SERIAL 04-59220

W 6 SUR
CHUCK COOK

CONSTRUCTION

HEATHKIT® MANUAL

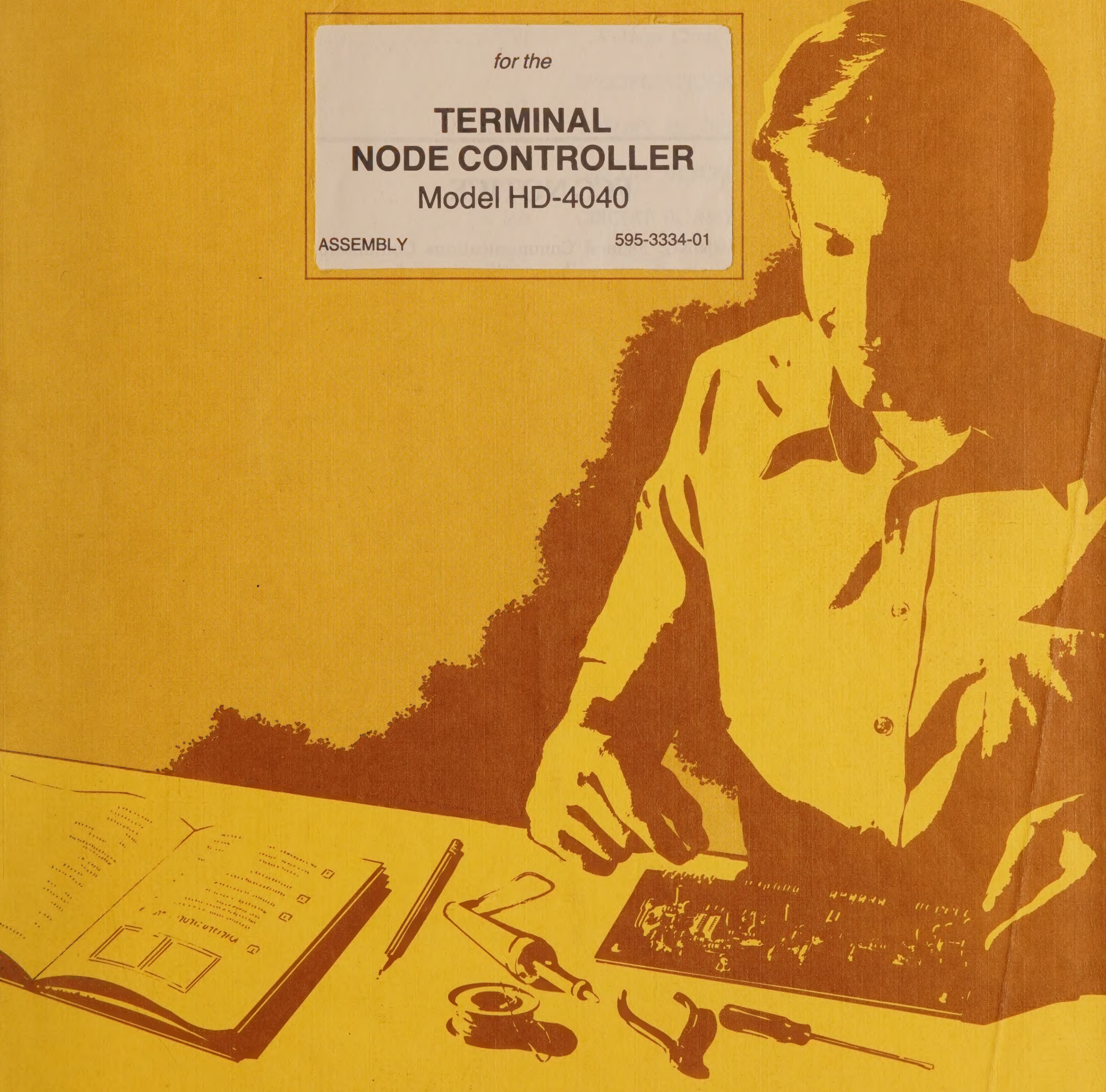
for the

TERMINAL NODE CONTROLLER

Model HD-4040

ASSEMBLY

595-3334-01



HEATH COMPANY • BENTON HARBOR, MICHIGAN

HEATH COMPANY PHONE DIRECTORY

The following telephone numbers are direct lines to the departments listed:

Kit orders and delivery information	(616) 982-3411
Credit	(616) 982-3561
Replacement Parts	(616) 982-3571

Technical Assistance Phone Numbers
8:00 A.M. to 12 P.M. and 1:00 P.M. to 4:30 P.M., EST, Weekdays Only

Audio	(616) 982-3310
Amateur Radio	(616) 982-3296
Test Equipment, Weather Instruments and Home Clocks	(616) 982-3315
Television	(616) 982-3307
Aircraft, Marine, Security, Scanners, Automotive, Appliances and General Products	(616) 982-3496
Computers — Hardware	(616) 982-3309
Computers — Software:	
Operating Systems, Languages, Utilities	(616) 982-3860
Application Programs	(616) 982-3884

YOUR HEATHKIT 90-DAY LIMITED WARRANTY

Consumer Protection Plan for Heathkit Consumer Products

Welcome to the Heath family. We believe you will enjoy assembling your kit and will be pleased with its performance. Please read this Consumer Protection Plan carefully. It is a "LIMITED WARRANTY" as defined in the U.S. Consumer Product Warranty and Federal Trade Commission Improvement Act. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Heath's Responsibility

PARTS — Replacements for factory defective parts will be supplied free for 90 days from date of purchase. Replacement parts are warranted for the remaining portion of the original warranty period. You can obtain warranty parts direct from Heath Company by writing or telephoning us at (616) 982-3571. And we will pay shipping charges to get those parts to you . . . anywhere in the world.

SERVICE LABOR — For a period of 90 days from the date of purchase, any malfunction caused by defective parts or error in design will be corrected at no charge to you. You must deliver the unit at your expense to the Heath factory, any Heathkit Electronic Center (units of Veritechnology Electronics Corporation), or any of our authorized overseas distributors.

TECHNICAL CONSULTATION — You will receive free consultation on any problem you might encounter in the assembly or use of your Heathkit product. Just drop us a line or give us a call. Sorry, we cannot accept collect calls.

NOT COVERED — The correction of assembly errors, adjustments, calibration, and damage due to misuse, abuse, or negligence are not covered by the warranty. Use of corrosive solder and/or the unauthorized modification of the product or of any furnished component will void this warranty in its entirety. This warranty does not include reimbursement for inconvenience, loss of use, customer assembly, set-up time, or unauthorized service.

This warranty covers only Heath products and is not extended to other equipment or components that a customer uses in conjunction with our products.

SUCH REPAIR AND REPLACEMENT SHALL BE THE SOLE REMEDY OF THE CUSTOMER AND THERE SHALL BE NO LIABILITY ON THE PART OF HEATH FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO ANY LOSS OF BUSINESS OR PROFITS, WHETHER OR NOT FORSEEABLE.

Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

Owner's Responsibility

EFFECTIVE WARRANTY DATE — Warranty begins on the date of first consumer purchase. You must supply a copy of your proof of purchase when you request warranty service or parts.

ASSEMBLY — Before seeking warranty service, you should complete the assembly by carefully following the manual instructions. Heathkit service agencies cannot complete assembly and adjustments that are customer's responsibility.

ACCESSORY EQUIPMENT — Performance malfunctions involving other non-Heath accessory equipment, (antennas, audio components, computer peripherals and software, etc.) are not covered by this warranty and are the owner's responsibility.

SHIPPING UNITS — Follow the packing instructions published in the assembly manuals. Damage due to inadequate packing cannot be repaired under warranty.

If you are not satisfied with our service (warranty or otherwise) or our products, write directly to our Director of Customer Service, Heath Company, Benton Harbor MI 49022. He will make certain your problems receive immediate, personal attention.

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Heathkit® Manual

for the

TERMINAL NODE CONTROLLER

Model HD-4040

ASSEMBLY 595-3334-01

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

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FCC NOTICE

WARNING: Federal Communications Commission requirements prescribe certification of personal computers and any interconnected peripherals in Part 15 Subpart J of the Rules and Regulations. This computing device will meet these requirements when constructed in strict accordance with the instructions in this Manual, using only components and materials supplied with the kit or the exact equivalent thereof. You will be instructed to sign and date the enclosed FCC ID label and affix the label to the equipment certifying that you have constructed this equipment in accordance with the above mentioned instructions. In order to meet legal requirements, be certain to follow the instructions exactly as they are stated in this Manual.

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* Portions of this Manual were copied directly from TAPR (Tucson Amateur Packet Radio) documentation.

INTRODUCTION

The Heathkit Model HD-4040 Terminal Node Controller (TNC) is designed as a link between your amateur radio station and a simple data terminal (or personal computer). This equipment allows you to operate using an exciting, new computer-based communications mode — packet radio. You will find this TNC convenient, and easy to use.

The most unique and important feature of the packet radio transmissions, unlike RTTY, is that they are virtually error-free. Information that you intend to transmit is first made into digital groups, or packets. Confirmation of correct reception of these packets is then returned to the originating station by the destination station. However, if the originating station does not receive confirmation, it automatically resends the packets until the correct information is confirmed, or the contact is terminated.

A modem (modulator/demodulator) that can operate at very high baud rates is included on the TNC circuit board. This results in very short transmissions by each station, allowing several stations to use the frequency at the same time. Also, due to the choice of operating parameters, you are not even aware of the presence of the other stations on the frequency.

Two banks of nonvolatile RAM (NOVRAM), which allow you to "customize" your operation, are included. You may, for example, set up one memory bank for "rag-chewing" and use the other bank for computer linking.

The TNC also functions as an automatic repeater. You may use it as an unattended repeater, beacon, or a "mailbox" with the appropriate computer and software. You may also use it with an FSK or AFSK FM station on the HF, VHF, UHF bands, and some of the OSCAR satellites.

NOTE: In addition to your regular amateur radio equipment, you will need either an ASCII data terminal or a personal computer that has an RS-232C output using a terminal emulator program. Such programs are widely available for connecting your computer to a modem; they are often used to access Compuserve or other computer telephone services.

You may also need a microphone connector to fit your equipment and an RS-232C serial interface cable.

UNPACKING INSTRUCTIONS

The shipping carton in which your kit was packed, contained this Manual and other papers. Refer to the "Pack Index Sheet" for the location of the sections inside the carton. Do not remove any parts from the carton until you are instructed to do so in a Parts List. There are two sections and each has its own Parts List, which you should read carefully. Pack #1 contains circuit board parts; while the remaining parts, some of which are wrapped, are mainly for the chassis.

IMPORTANT: To avoid intermixing parts, DO NOT remove anything from a parts pack until you are instructed to do so. After you identify any part that is packed in an envelope with a part number on it, place the part back in its envelope after you check it until that part is called for in a step.

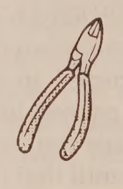
ASSEMBLY NOTES

TOOLS

You will need these tools to assemble your kit.

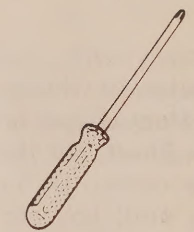
PLIERS

LONG-NOSE PLIERS



DIAGONAL CUTTERS

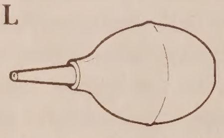
WIRE STRIPPERS



PHILLIPS SCREWDRIVER

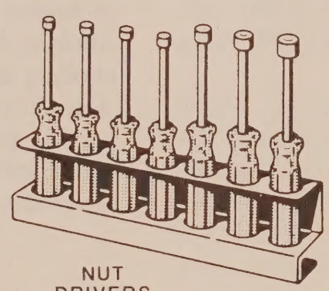
OTHER HELPFUL TOOLS

NUT STARTER (May Be Supplied With Kit)



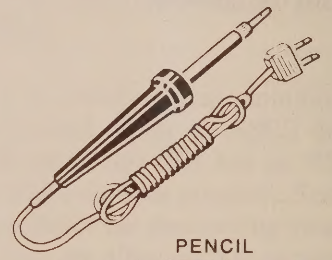
DESOLDERING BULB*

DESOLDERING BRAID*



NUT DRIVERS

*To Remove Solder From Circuit Connections.



PENCIL SOLDERING IRON (22to25 WATTS)

ASSEMBLY

1. Follow the instructions carefully. Read the entire step before you perform each operation.

2. The illustrations in the Manual are called Pictorials and Details. Pictorials show the overall operation for a group of assembly steps; Details generally illustrate a single step. When you are directed to refer to a certain Pictorial "for the following steps," continue using that Pictorial until you are referred to another Pictorial for another group of steps.

3. Most kits use a separate "Illustration Booklet" that contains illustrations (Pictorials, Details, etc.) that are too large for the Assembly Manual. Keep the "Illustration Booklet" with the Assembly Manual. The illustrations in it are arranged in Pictorial number sequence.

4. Position all parts as shown in the Pictorials.

5. Solder instructions are generally given only at the end of a series of similar steps. You may solder more often if you desire.

6. Each circuit part in an electronic kit has its own component number (R2, C4, etc.). Use these numbers when you want to identify the same part in the various sections of the Manual. These numbers, which are especially useful if a part has to be replaced, appear:

   — In the Parts List,

   — At the beginning of each step where a component is installed,

   — In some illustrations,

   — In Troubleshooting Charts,

   — In the Schematic,

   — In the sections at the rear of the Manual.

7. When you are instructed to cut something to a particular length, use the scales (rulers) provided at the bottom of the Manual pages.

SAFETY WARNING: Avoid eye injury when you cut off excessive lead lengths. Hold the leads so they cannot fly toward your eyes.

SOLDERING

Soldering is one of the most important operations you will perform while assembling your kit. A good solder connection will form an electrical connection between two parts, such as a component lead and a circuit board foil. A bad solder connection could prevent an otherwise well-assembled kit from operating properly.

It is easy to make a good solder connection if you follow a few simple rules:

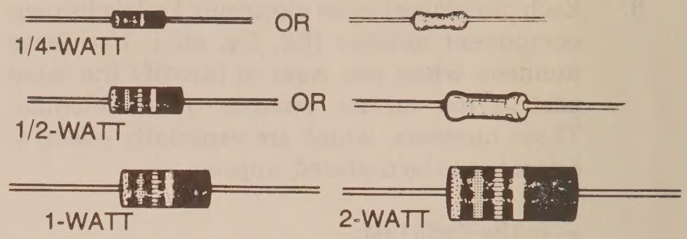
1. Use the right type of soldering iron. A 22 to 25-watt pencil soldering iron with a 1/8″ or 3/16″ chisel or pyramid tip works best.

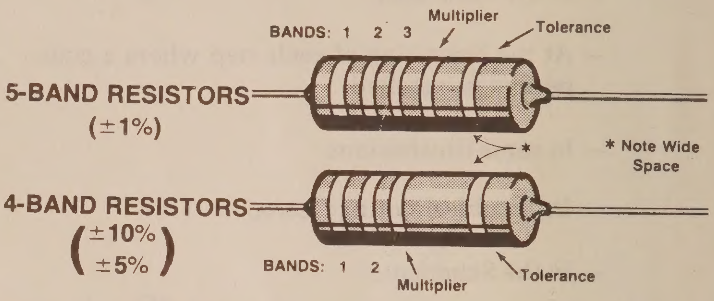
2. Keep the soldering iron tip clean. Wipe it often on a wet sponge or cloth; then apply solder to the tip to give the entire tip a wet look. This process is called tinning, and it will protect the tip and enable you to make good connections. When solder tends to "ball" or does not stick to the tip, the tip needs to be cleaned and retinned.

NOTE: Always use rosin core, radio-type solder (60:40 tin-lead content) for all of the soldering in this kit. This is the type we have supplied with the parts. The Warranty will be void and we will not service any kit in which acid core solder or paste has been used.

PARTS

Resistors are identified in Parts Lists and steps by their resistance value in Ω (ohms), kΩ (kilohms), or MΩ (megohms). They are usually identified by a color code and four or five color bands, where each color represents a number. These colors (except for the last band, which indicates a resistor's "tolerance") will be given in the steps in their proper order. Therefore, the following color code is given for information only. NOTE: Occasionally, a "precision" or "power" resistor may have the value stamped on it.





Band 1 1st Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

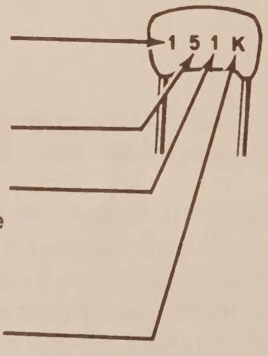
Band 2 2nd Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

Band 3 (if used) 3rd Digit	
Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Gray	8
White	9

Multiplier	
Color	Multiplier
Black	1
Brown	10
Red	100
Orange	1,000
Yellow	10,000
Green	100,000
Blue	1,000,000
Silver	0.01
Gold	0.1

Resistance Tolerance	
Color	Tolerance
Silver	± 10%
Gold	± 5%
Red	± 2%
Brown	± 1%
Green	± .5%
Blue	±.25%
Violet	± .1%
Gray	±.05%

Capacitors will be called out by their capacitance value in μF (microfarads) or pF (picofarads) and type: ceramic, Mylar*, electrolytic, etc. Some capacitors may have their value printed in the following manner:



First digit of capacitor's value: 1

Second digit of capacitor's value: 5

Multiplier: Multiply the first & second digits by the proper value from the Multiplier Chart.

To find the tolerance of the capacitor, look up this letter in the Tolerance columns.

EXAMPLES:

151K = 15 × 10 = 150 pF
759 = 75 ×0.1 = 7.5 pF

NOTE: The letter "R" may be used at times to signify a decimal point: as in: 2R2 = 2.2 (pF or μF).

MULTIPLIER		TOLERANCE OF CAPACITOR		
FOR THE NUMBER:	MULTIPLY BY:	10 pF OR LESS	LETTER	OVER 10 pF
0	1	±0.1 pF	B	
1	10	±0.25 pF	C	
2	100	±0.5 pF	D	
3	1000	±1.0 pF	F	±1%
4	10,000	±2.0 pF	G	±2%
5	100,000		H	±3%
			J	±5%
8	0.01		K	±10%
9	0.1		M	±20%

---

*DuPont Registered Trademark.

CIRCUIT BOARD

PARTS LIST

Remove the parts from "Pack 1" and check each part against the following list. The key numbers correspond to the numbers on the "Circuit Board Parts Pictorial". Return any part that is in an individual envelope, back into the envelope, after you have identified it, until that part is called for in a step. Do not throw away any packing material until you account for all the parts.

To order a replacement part, always include the PART NUMBER. Use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover of this Manual. For prices, refer to the separate "Heath Parts Price List."

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
CAPACITORS				
Ceramic				
✓A1	21-722	3	330 pF (330 K)	C9, C10, C11
✓A1	21-164	2	.0015 μF	C29, C30
✓A1	21-176	7	.01 μF	C13, C15, C31, C33, C61, C63, C64
✓A1	21-143	2	.05 μF	C18, C28
✓A1	21-809	1	.15 μF	C23
✓A2	21-762	1	.1 μF (104) axial-lead	C19
Electrolytic				
✓A3	25-900	2	1 μF	C17, C19
✓A3	25-880	3	10 μF	C6, C7, C32
✓A3	25-885	1	100 μF	C12
✓A3	25-889	1	330 μF	C14
✓A3	25-905	2	470 μF	C3, C5
✓A3	25-895	1	2200 μF	C1

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
Mylar®				
✓A4	27-70	1	.0022 μF (222K)	C21
✓A4	27-229	1	.0047 μF	C20
✓A4	27-128	2	.022 μF (223K)	C16, C22
CONTROLS				
✓B1	10-1154	2	10 kΩ (103)	R36, R43
✓B1	10-1230	1	20 kΩ (203)	R38
✓B1	10-1200	1	50 kΩ (503)	R33
✓B1	10-1180	1	100 kΩ (104)	R31

TRANSISTORS — INTEGRATED CIRCUITS (ICs)

NOTE: Transistors and integrated circuits may be marked for identification in any one of the following four ways:

1. Part number.
2. Type number. (For integrated circuits, this refers only to the numbers and letters shown in **BOLD** print in the Parts List. Disregard any other numbers or letters shown on the IC.)
3. Part number and type number.
4. Part number with a type number other than the one shown.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
C1	417-999	2	VN10KM transistor (FET)	Q1, Q2
C2	442-665	1	**79L05** IC	U29
C2	442-627	1	**78L05** IC	U33
C3	442-674	1	**7812**	U22
C3	442-675	1	**7912**	U23

PLUGS — SOCKETS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
D1	432-1200	5	2-pin plug	JP1-JP5
D2	432-1265	3	3-pin plug	JP6-JP8
D3	432-828	1	7-pin plug	J4
D4	432-1041	13	Jumper socket	
D5	432-1358	1	9-pin right angle socket	J3
D6	432-1194	1	25-pin right angle socket*	J2
D7	432-1195	1	25-pin right angle plug*	J1
D8	432-1427	1	14-pin plug	U35
D9	432-1012	2	16-pin plug	U30, U34
D10	434-230	3	8-pin IC socket	
D10	434-298	11	14-pin IC socket	
D10	434-299	5	16-pin IC socket	
D10	434-310	1	18-pin IC socket	
D10	434-311	1	20-pin IC socket	
D10	434-312	7	28-pin IC socket	
D10	434-253	4	40-pin IC socket	
D11	432-1426	1	20-pin latching connector	J5

* These parts may have a removable spacer over the pins which can easily fall off. Make sure it stays in place.

CABLE — WIRE — SLEEVING

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
	343-12	96″	Coaxial cable	
	344-2	24″	Black wire	
	344-199	48″	White wire	
	346-1	2-1/2″	Fiber sleeving	
	346-20	1-1/2″	Heat-shrinkable sleeving	

HARDWARE

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
E1	250-1412	6	4-40 x 3/8″ black phillips screw	
E2	252-15	6	4-40 nut	
E3	254-9	6	#4 lockwasher	

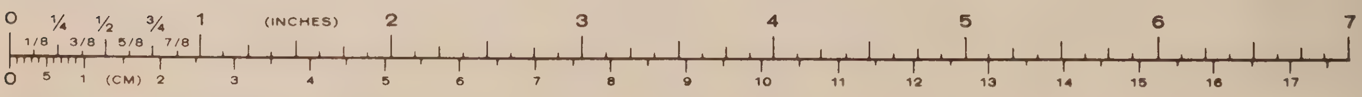
MISCELLANEOUS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
F1	57-42	4	3A1 diode	D13-D16
F2	60-638	1	DIP switch	SW
F3	404-657	1	7.3728 MHz crystal	Y1
F4	412-640	8	LST5053 LED	D1-D8
F5	490-5	1	Nut starter	
	597-260	1	Parts Order Form**	
	597-3866	1	Quick Reference Guide**	
	597-4020	1	Registration Card**	
	597-4021	1	Hookup Instructions for Various Transceivers**	
	597-4022	1	Radio Interfacing Data Sheet**	
		1	Assembly Manual (see front page for part number)	
		1	User's Manual (see front page for part number)	
			Solder	

PART FROM FINAL PACK

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
	85-3033-1	1	Circuit Board	

** Packed inside the Assembly Manual.



TAPED COMPONENTS

Refer to the last page(s) of the Illustration Booklet and remove the "Taped Components Chart." Then follow the instructions at the top of that chart to prepare the taped parts. The taped parts are in assembly sequence. It is not necessary to check them against the Parts List.

RESISTORS

NOTE: The resistors are 1/4-watt with a tolerance of 5% unless stated otherwise. 5% is indicated by a gold fourth color band. 1% resistors have a brown fifth color band. The fourth and fifth bands will not be called out.

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
6-201-12	1	200 Ω (red-blk-brn)	R39
6-331-12	12	330 Ω (org-org-brn)	R16-R27
6-471-12	1	470 Ω (yel-viol-brn)	R87
6-681-12	5	680 Ω (blu-gry-brn)	R76-R79, R81
6-102-12	7	1000 Ω (brn-blk-red)	R12, R13, R42, R64, R65, R71, R80
6-332-12	1	3300 Ω (org-org-red)	R67
6-472-12	15	4700 Ω (yel-viol-red)	R8, R9, R10, R11, R29, R32, R34, R49, R50, R72, R73, R74, R75, R86, R88
6-682-12	1	6800 Ω (blu-gry-red)	R2
6-103-12	12	10 kΩ (brn-blk-org)	R5, R6, R7, R30, R40, R60, R61, R69, R82, R83, R84, R85
6-1002-12	4	10 kΩ, 1% (brn-blk-blk-red)	R51, R54, R55, R57
6-1622-12	2	16.2 kΩ, 1% (brn-blu-red-red)	R35, R56
6-2212-12	1	22.1 kΩ, 1% (red-red-brn-red)	R47
6-2372-12	1	23.7 kΩ, 1% (red-org-viol-red)	R37
6-303-12	1	30 kΩ (org-blk-org)	R41
6-333-12	3	33 kΩ (org-org-org)	R1, R3, R4
6-3742-12	1	37.4 kΩ, 1% (org-viol-yel-red)	R58
6-393-12	2	39 kΩ (org-wht-org)	R62, R63
6-4752-12	1	47.5 kΩ, 1% (yel-viol-grn-red)	R46
6-5762-12	1	57.6 kΩ, 1% (grn-viol-blu-red)	R53
6-6342-12	1	63.4 kΩ, 1% (blu-org-yel-red)	R52
6-683-12	1	68 kΩ (blu-gry-org)	R66
6-104-12	5	100 kΩ (brn-blk-yel)	R15, R28, R68, R70, R82
6-1003-12	1	100 kΩ, 1% (brn-blk-blk-org)	R45
6-474-12	1	470 kΩ (yel-viol-yel)	R48
6-514-12	1	510 kΩ (grn-brn-yel)	R44

CAPACITOR

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
21-762	35	.1 µF (104) axial-lead ceramic	C2, C4, C8, C24-C27, C34-C60, C62
21-784	1	.001 µF (102) axial-lead ceramic	C65

DIODES

HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
56-56	2	1N4149	D21, D22
56-604	1	1N4752A zener	D19
57-65	6	1N4002	D9, D10, D11, D12, D17, D18

STEP-BY-STEP ASSEMBLY

Refer to Pictorial 1-1 as you read the following notes and steps.

NOTES:

1. Many circuit board drawings, such as the one shown in Pictorial 1-1, are divided into two or more sections. These sections show you which area of the circuit board you are working in for a specific series of steps.

2. Usually, each series of steps has you installing parts in a top-to-bottom, left-to-right sequence. But occasionally this sequence may be altered briefly so you can install smaller (lower) parts before the larger (higher) parts.

3. Check off each step as you perform it. You may also wish to place a check mark near each component on the Pictorial as you install it.

4. In general, solder instructions are given only at the end of a series of similar steps. However, you may solder more often, if you desire.

5. The circuit board has foil on both sides, but only one side has the component outlines shown on it. This side is referred to as the "component side"; and it is on this side that you will install the components, unless you are directed otherwise.

In order to make the assembly easier, you may wish to precut all the parts from a section. As you do, prebend the leads and lay the parts on your work surface in the order of assembly. Then you can hold the circuit board while you install the parts in sequence without interruption.

In the following steps, you will be given detailed instructions on how to install and solder the first part on the circuit board. Read and perform each step carefully. Then use the same procedure whenever you install parts on the circuit board.

Taped Components Chart

Refer to the "Taped Components Chart" before you begin. You will be installing the taped components first. They are in assembly sequence.

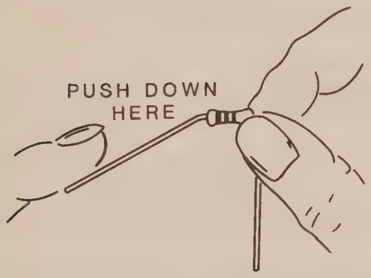
Make sure that you do not install a taped component out-of-sequence; otherwise, the remaining components will also be out-of-sequence.

The circuit board is divided into sections that match the sections on the "Taped Components Chart." Match the taped components strip sections with the sections for each series of steps.

Section 1

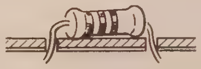
(✓) Position the circuit board as shown in the Pictorial with the component side facing up. Then start at the top of Section 1 to install the first part.

(✓) R10: Cut the first component, a 4700 Ω (yel-viol-red) resistor from the taped components strip. Hold the resistor by the body, as shown, and bend the leads straight down with your finger to fit the hole spacing on the circuit board.

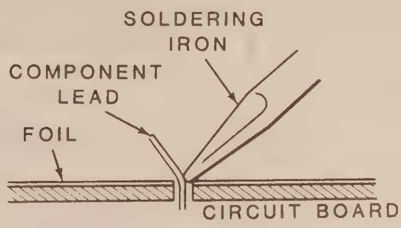


(✓) Start the resistor leads into their circuit board holes at the indicated location.

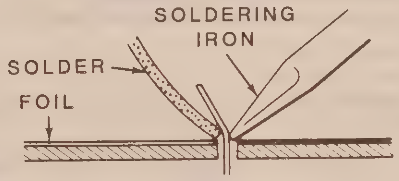
(✓) Press the resistor body against the circuit board and bend the leads outward slightly to hold it in place.



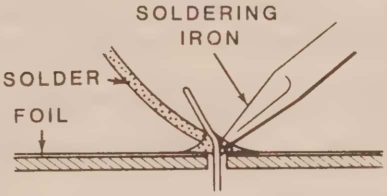
Solder the resistor leads to the circuit board as follows:



1. Push the soldering iron tip against both the lead and the circuit board foil. Heat **both** for two or three seconds.



2. Then apply solder to the other side of the connection. IMPORTANT: Let the heated lead and the circuit board foil melt the solder.

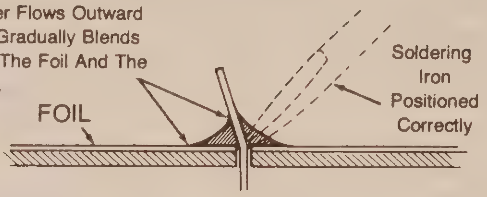


3. As the solder begins to melt, allow it to flow around the connection. Then remove the solder and the iron and let the connection cool.

(✓) Cut off the excess lead lengths close to the connection. WARNING: Clip the leads so the ends will not fly toward your eyes.

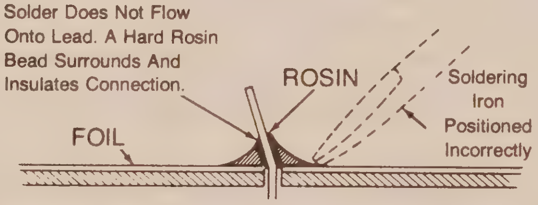
( ) Check each solder connection and compare it to the illustrations on Page 1-6. After you have checked the connections, proceed with the assembly. Use the same soldering procedure for each component.

A GOOD SOLDER CONNECTION

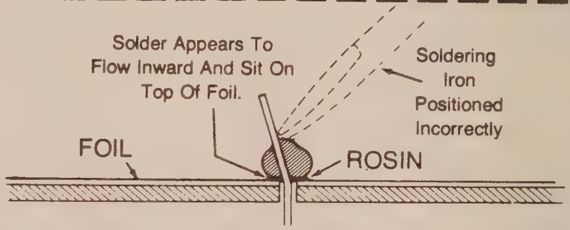

Solder Flows Outward And Gradually Blends With The Foil And The Lead.
FOIL
Soldering Iron Positioned Correctly

When you heat the lead and the circuit board foil at the same time, the solder will flow evenly onto the lead and the foil. The solder will make a good electrical connection between the lead and the foil.

POOR SOLDER CONNECTIONS


Solder Does Not Flow Onto Lead. A Hard Rosin Bead Surrounds And Insulates Connection.
ROSIN
FOIL
Soldering Iron Positioned Incorrectly

When the lead is not heated sufficiently, the solder will not flow onto the lead as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.

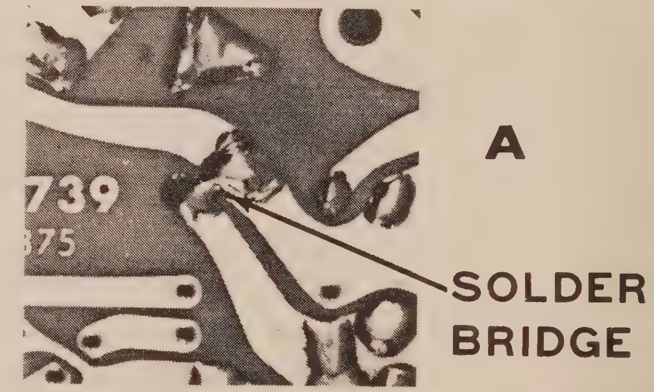

Solder Appears To Flow Inward And Sit On Top Of Foil.
FOIL
ROSIN
Soldering Iron Positioned Incorrectly

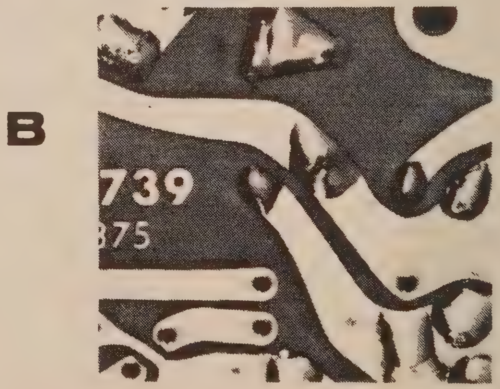
When the foil is not heated sufficiently the solder will blob on the circuit board as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.

SOLDER BRIDGES

A solder bridge between two adjacent foils is shown in photograph **A**. Photograph **B** shows how the connection should appear. A solder bridge may occur if you accidentally touch an adjacent previously soldered connection, if you use too much solder, or if you "drag" the soldering iron across other foils as you remove it from the connection. A good rule to follow is: always take a good look at the foil area around each lead before you solder it. Then, when you solder the connection, make sure the solder remains in this area and does not bridge to another foil. This is especially important when the foils are small and close together. NOTE: It is alright for solder to bridge two connections on the same foil.

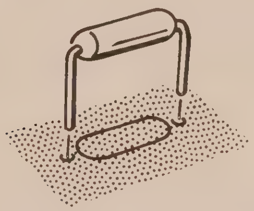
Use only enough solder to make a good connection, and lift the soldering iron straight up from the circuit board. If a solder bridge should develop, turn the circuit board foil-side-down and heat the solder between connections. The excess solder will run onto the tip of the soldering iron, and this will remove the solder bridge. NOTE: The foil side of most circuit boards has a coating on it called "solder resist." This is a protective insulation to help prevent solder bridges.





( ) Make sure you installed the first part on Page 1-5. Then continue to install components in Section 1 of the circuit board at the following locations:

NOTE: When you install an axial-lead ceramic capacitor, as in the following step, form the leads as shown to fit the hole spacing on the circuit board.



(✓) C8: .1 µF (104) axial-lead ceramic capacitor.

(✓) R9: 4700 Ω (yel-viol-red) resistor.

( ) R11: 4700 Ω (yel-viol-red) resistor.

( ) R88: 4700 Ω (yel-viol-red) resistor.

( ) R12: 1000 Ω (brn-blk-red) resistor.

( ) R13: 1000 Ω (brn-blk-red) resistor.

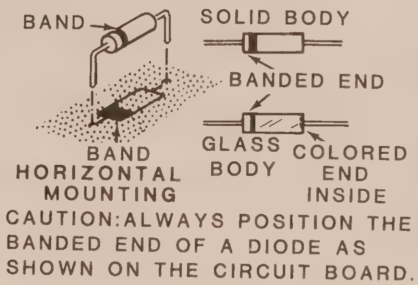
( ) R8: 4700 Ω (yel-viol-red) resistor.

(✓) R87: 470 Ω (yel-viol-brn) resistor.

( ) C45: .1 µF (104) axial-lead ceramic capacitor.

(✓) C2: .1 µF (104) axial-lead ceramic capacitor.

NOTE: In the following steps, you will install diodes. Whenever you install a diode, always match its banded end with the band shown on the circuit board. A diode will not work properly if it is installed backwards.


BAND
SOLID BODY
BANDED END
BAND
HORIZONTAL MOUNTING
GLASS BODY
COLORED END INSIDE
CAUTION: ALWAYS POSITION THE BANDED END OF A DIODE AS SHOWN ON THE CIRCUIT BOARD.

The next four diodes are not on the taped strip.

Install four 3A1 (#57-42) diodes on the circuit board at the following locations:

( ) D16.
( ) D14.
( ) D13.
( ) D15.

Install four 1N4002 (#57-65) diodes on the circuit board at the following locations:

( ) D11.
( ) D9.
( ) D10.
( ) D12.

( ) Solder the leads to the foil and cut off the excess lead lengths.

Section 2

Install ten .1 μF (104) axial-lead ceramic capacitors at the following locations.

(✓) C34.
(✓) C35.
( ) C36.
( ) C46.
( ) C51.
( ) C47.
( ) C4.
( ) C48.
( ) C49.
(✓) C50.

(✓) D17: 1N4002 diode (#57-65).

(✓) D18: 1N4002 diode (#57-65).

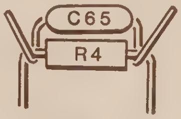
(✓) R83: 10 kΩ (brn-blk-org) resistor.

(✓) R82: 10 kΩ (brn-blk-org) resistor.

(✓) R1: 33 kΩ (org-org-org) resistor.

(✓) R4: 33 kΩ (org-org-org) resistor.

(✓) C65: .001 μF (102) axial-lead ceramic. Wrap the leads of this capacitor around the leads of resistor R4 as shown. Then solder the leads to the resistor and cut off the excess capacitor leads.



(✓) R2: 6800 Ω (blu-gry-red) resistor.

(✓) R3: 33 kΩ (org-org-org) resistor.

(✓) R85: 10 kΩ (brn-blk-org) resistor.

( ) R84: 10 kΩ (brn-blk-org) resistor.

(✓) Solder the leads to the foil and cut off the excess lead lengths.

Section 3

Install five .1 μF (104) axial-lead ceramic capacitors at the following locations.

(✓) C37.
(✓) C38.
(✓) C39.
(✓) C42.
(✓) C43.

(✓) R15: 100 kΩ (brn-blk-yel) resistor.

Install six 4700 Ω (yel-viol-red) resistors on the circuit board at the following locations:

( ) R50.
( ) R73.
( ) R74.
( ) R75.
( ) R86
( ) R34.

Install four 680 Ω (blu-gry-brn) resistors on the circuit board at the following locations:

(✓) R76. NOTE: Be sure you do not cut off the upper lead of this resistor after you solder its leads to the foil.
(✓) R77.
(✓) R79.
(✓) R78.

(✓) R72: 4700 Ω (yel-viol-red) resistor.

(✓) C52: .1 μF (104) axial-lead ceramic capacitor.

(✓) R29: 4700 Ω (yel-viol-red) resistor.

(✓) R30: 10 kΩ (brn-blk-org) resistor.

(✓) D19: 1N4752A zener diode (#56-604).

NOTE: You will not install a component on the circuit board at R59.

(✓) R32: 4700 Ω (yel-viol-red) resistor.

(✓) R82: 100 kΩ (brn-blk-yel) resistor.

(✓) C62: .1 μF (104) axial-lead ceramic capacitor.

(✓) C26: .1 μF (104) axial-lead ceramic capacitor.

(✓) C27: .1 μF (104) axial-lead ceramic capacitor.

(✓) C60: .1 μF (104) axial-lead ceramic capacitor.

(✓) Solder the leads to the foil and cut off the excess lead lengths except the upper lead of R76.

Section 4

(✓) C40: .1 µF (104) axial-lead ceramic capacitor.

(✓) C41: .1 µF (104) axial-lead ceramic capacitor.

(✓) R6: 10 kΩ (brn-blk-org) resistor.

(✓) R7: 10 kΩ (brn-blk-org) resistor.

Install six 330 Ω (org-org-brn) resistors on the circuit board at the following locations:

(✓) R24.
(✓) R25.
(✓) R26.
(✓) R27.
(✓) R22.
(✓) R23.

(✓) R5: 10 kΩ (brn-blk-org) resistor.

(✓) C44: .1 µF (104) axial-lead ceramic capacitor.

(✓) R65: 1000 Ω (brn-blk-red) resistor.

(✓) C54: .1 µF (104) axial-lead ceramic capacitor.

(✓) C55: .1 µF (104) axial-lead ceramic capacitor.

(✓) C53: .1 µF (104) axial-lead ceramic capacitor.

(✓) R39: 200 Ω (red-blk-brn) resistor.

(✓) C25: .1 µF (104) axial-lead ceramic capacitor.

(✓) R40: 10 kΩ (brn-blk-org) resistor.

(✓) R49: 4700 Ω (yel-viol-red) resistor.

(✓) R81: 680 Ω (blu-gry-brn) resistor.

(✓) C57: .1 µF (104) axial-lead ceramic capacitor.

(✓) C56: .1 µF (104) axial-lead ceramic capacitor.

(✓) C24: .1 µF (104) axial-lead ceramic capacitor.

(✓) R60: 10 kΩ (brn-blk-org) resistor.

(✓) R80: 1000 Ω (brn-blk-red) resistor.

(✓) R61: 10 kΩ (brn-blk-org) resistor.

(✓) R62: 39 kΩ (org-wht-org) resistor.

(✓) R63: 39 kΩ (org-wht-org) resistor.

(✓) R71: 1000 Ω (brn-blk-red) resistor.

(✓) D21: 1N4149 diode (#56-56).

(✓) C59: .1 µF (104) axial-lead ceramic capacitor.

(✓) C58: .1 µF (104) axial-lead ceramic capacitor.

(✓) D22: 1N4149 diode (#56-56).

( ) Solder the leads to the foil and cut off the excess lead lengths.

Section 5

Install six 330 Ω (org-org-brn) resistors on the circuit board at the following locations:

(✓) R18.
( ) R19.
( ) R20.
( ) R21.
( ) R16.
( ) R17.

(✓) R64: 1000 Ω (brn-blk-red) resistor.

(✓) R41: 30 kΩ (org-blk-org) resistor.

(✓) R42: 1000 Ω (brn-blk-red) resistor.

(✓) R67: 3300 Ω (org-org-red) resistor.

(✓) R66: 68 kΩ (blu-gry-org) resistor.

(✓) R48: 470 kΩ (yel-viol-yel) resistor.

(✓) R68: 100 kΩ (brn-blk-yel) resistor.

(✓) R70: 100 kΩ (brn-blk-yel) resistor.

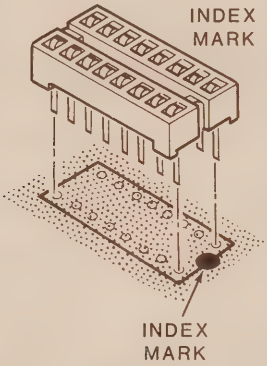
(✓) R69: 10 kΩ (brn-blk-org) resistor.

( ) Solder the leads to the foil and cut off the excess lead lengths.

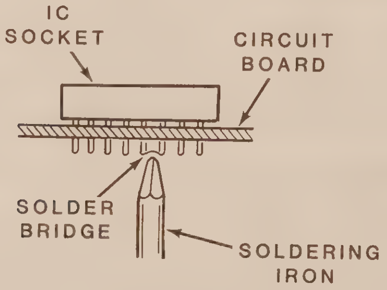
NOTE: You will install the remaining taped components later. Leave them attached to the sheet and set the sheet aside for now.

Refer to Pictorial 1-2 for the following steps.

NOTE: You will install IC sockets in the following steps. Each of these sockets will have an identification mark on one end of the socket (an arrow, a dot, or a notch). Always position this end of the socket toward the index mark on the circuit board. Straighten any bent pins, and then insert the pins into the circuit board holes. Hold the socket firmly against the board and solder one pin at diagonally opposite corners of the socket. When the solder cools, check to make sure the socket is tight against the circuit board. If not, reheat the pins while you press the socket against the board; then solder the remaining pins.



It is very easy to form a solder bridge between the closely spaced IC socket foils. Therefore, after each solder step, carefully inspect the foil for solder bridges and remove any that may have formed. To remove a solder bridge, hold the circuit board foil-side-down as shown, and hold the soldering iron tip between the two points that are bridged. The solder will flow down the soldering iron tip to clear the bridge.



Section 1

Install IC sockets in Section 1 of the circuit board at the following locations:

(✓) 14-pin IC socket at U1.

(✓) 40-pin IC socket at U5.

(✓) 28-pin IC socket at U7.

(✓) 28-pin IC socket at U8.

(✓) 14-pin IC socket at U2.

(✓) 16-pin IC socket at U4.

(✓) 14-pin IC socket at U3.

(✓) 28-pin IC socket at U14.

(✓) 14-pin IC socket at U36.

(✓) 14-pin IC socket at U15.

(✓) 14-pin IC socket at U16.

Section 2

Install 28-pin IC sockets on the circuit board at the following four locations:

( ) U9.
(✓) U10.
( ) U11.
( ) U12.

(✓) 40-pin IC socket at U13.

(✓) 40-pin IC socket at U17.

(✓) 14-pin IC socket at U25.

(✓) 8-pin IC socket at U26.

Section 3

(✓) 40-pin IC socket at U6.

(✓) 18-pin IC socket at U27.

(✓) 16-pin IC socket at J6.

(✓) 14-pin IC socket at U32.

(✓) 14-pin IC socket at U21.

(✓) 8-pin IC socket at U31.

(✓) 14-pin IC socket at U35.

(✓) 16-pin IC socket at U19.

(✓) 14-pin IC socket at U18.

(✓) 16-pin IC socket at U34.

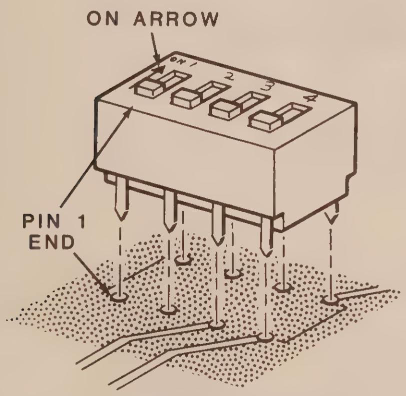
(✓) 8-pin IC socket at U20.

(✓) 16-pin IC socket at U30.

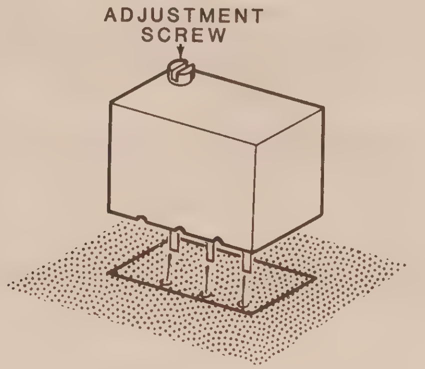
(✓) 20-pin IC socket at U28.

NOTE: In the following steps you will install the lower size components first, and then the larger components in ascending size.

(✓) SW: Mount the DIP switch on the circuit board at SW in Section 3. Make sure you keep the switch flat against the board with the ON arrow positioned as shown. Solder the pins to the foil after you install the switch.



NOTE: When you install the following controls, keep them flat against the board with the adjustment screw as shown. Solder the pins to the foil after you install each control and cut off any excess pin lengths.



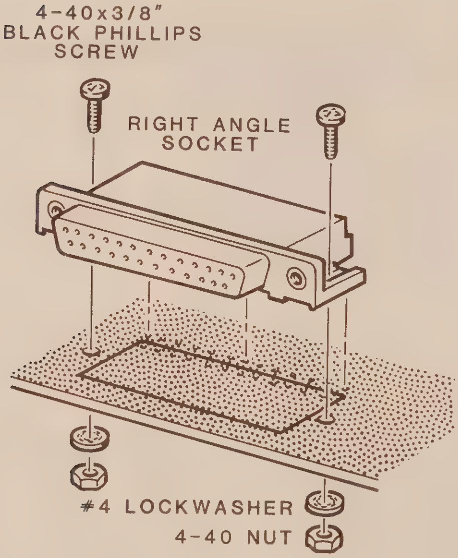
Install controls in Section 3 of the circuit board at the following locations:

( ) R38: 20 kΩ (203).
( ) R36: 10 kΩ (103).
( ) R31: 100 kΩ (104).
( ) R33: 50 kΩ (503).
( ) R43: 10 kΩ (103).

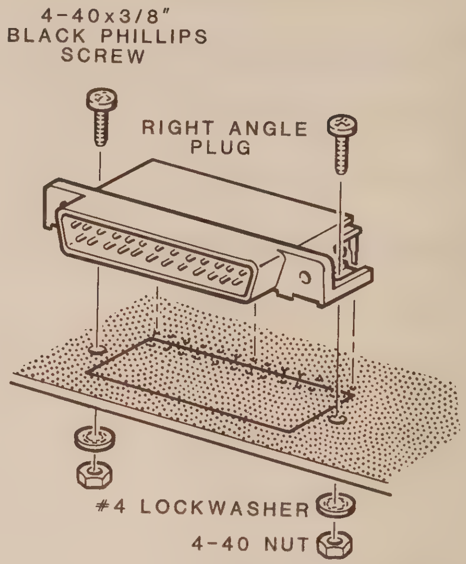
Refer to Pictorial 1-3 for the following steps.

NOTE: When you install some of the plugs and sockets in the following steps, you will install the smaller (lower) ones first. Straighten any bent pins before you install the socket or plug; then insert all of the pins into the circuit board holes and press the body against the circuit board. Install the hardware as directed and then solder the pins to the foil.

(✓) J2: Install the 25-pin right angle socket at J2 in Section 1 of the circuit board with two 4-40 × 3/8" black phillips screws, two #4 lockwashers, and two 4-40 nuts. Use the nut starter to hold and start 4-40 and 6-32 nuts on screws.



(✓) J1: Similarly install the 25-pin right angle plug at J1 in Section 1 of the circuit board with 4-40 × 3/8" black phillips screws, #4 lockwashers, and 4-40 nuts.

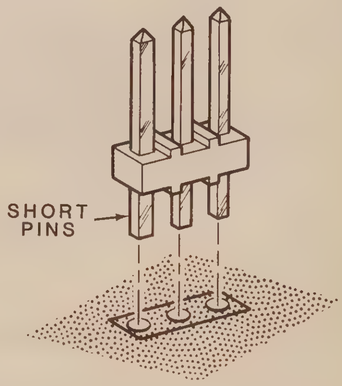


( ) J3: Similarly install the 9-pin right angle socket at J3 in Section 2 of the circuit board with 4-40 × 3/8" black phillips screws, #4 lockwashers, and 4-40 nuts.

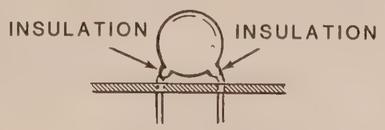
Section 1

Install three 3-pin plugs on the circuit board as follows. Insert the shorter pins into the circuit board holes and solder them to the foil. Keep each plug body flat against the board.

(✓) JP7.
(✓) JP8.
(✓) JP6.



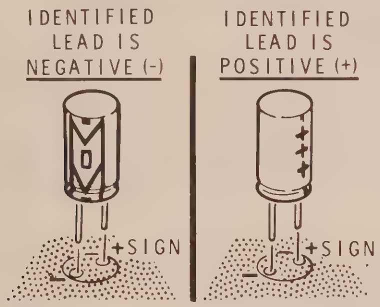
NOTE: When you install ceramic capacitors, as in the following steps, do not push the insulated portion of the leads into the circuit board holes. This could make it difficult to solder the leads to the foil.



Install three 330 pF ceramic capacitors on the circuit board at the following locations:

(✓) C11.
(✓) C9.
(✓) C10.

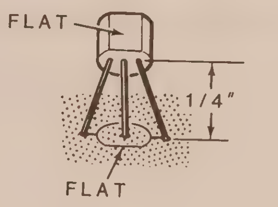
NOTE: Before you install an electrolytic capacitor, look at it and idientify the markings near the leads. One lead will have a positive (+) mark or a negative (−) mark near it. Be sure to install the positive lead in the positive-marked hole or the negative lead in the negative-marked hole. Be careful; only the negative lead may be marked.


IDENTIFIED LEAD IS NEGATIVE (-)
IDENTIFIED LEAD IS POSITIVE (+)
+SIGN
+SIGN

Install two 10 µF electrolytic capacitors on the circuit board at the following locations:

( ) C6.
( ) C7.

NOTE: Whenever you mount an IC or a transistor like the one shown in the following step, position it with the case flat over the flat shown on the circuit board and with the bottom of the case 1/4″ above the circuit board.



(✓) U29: 79L05 IC (#442-665). Do not confuse this part with the 78L05.

(✓) Solder the leads to the foil and cut off the excess lead lengths. NOTE: Save one of the cutoff electrolytic capacitor leads for use later.

Section 2

Install three 2-pin plugs on the circuit board at the following locations. Solder each plug to the foil after you install it.

(✓) JP5.
(✓) JP4.
(✓) JP2.

( ) C15: .01 µF ceramic capacitor.

( ) C13: .01 µF ceramic capacitor.

(✓) Q1: VN10KM transistor (#417-999).

Install three .01 µF ceramic capacitors on the circuit board at the following locations:

(✓) C61.
(✓) C63.
(✓) C64.

(✓) U33: 78L05 IC (#442-627).

(✓) Solder the leads to the foil and cut off the excess lead lengths.

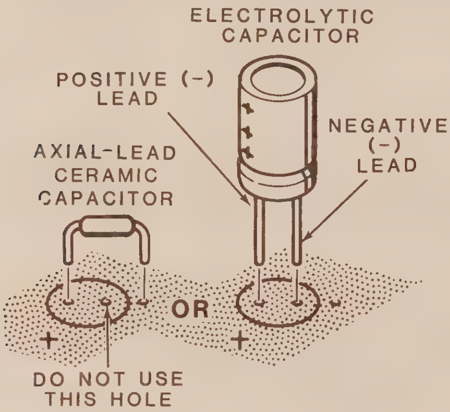
Section 3

(✓) C18: .05 μF ceramic capacitor.

(✓) Q2: VN10KM transistor (#417-999).

(✓) C23: .15 μF ceramic capacitor.

NOTE: Refer to your transceiver manual to determine the impedance of your microphone. If you intend to use a low-impedance microphone (less than 3000 ohms) with the unit, use a 1 μF electrolytic capacitor in the following step. If you intend to use a high-impedance microphone, use a .1 μF (104) axial-lead ceramic capacitor. The correct holes for each type of capacitor are shown below. Most microphones have a high impedance. However, if you are unsure, use the low-impedance (1 μF) capacitor.



(✓) C19: .1 μF (104) axial-lead ceramic capacitor or 1 μF electrolytic capacitor.

(✓) C17: 1 μF electrolytic capacitor.

(✓) C32: 10 μF electrolytic capacitor.

(✓) JP1: 2-pin plug. Solder the plug pins to the foil.

NOTE: You will not install a plug at J7.

(✓) C28: .05 μF ceramic capacitor.

(✓) C30: .0015 μF ceramic capacitor. Reform the capacitor leads to fit the hole spacing.

(✓) C31: .01 μF ceramic capacitor.

(✓) C29: .0015 μF ceramic capacitor.

(✓) C33: .01 μF ceramic capacitor.

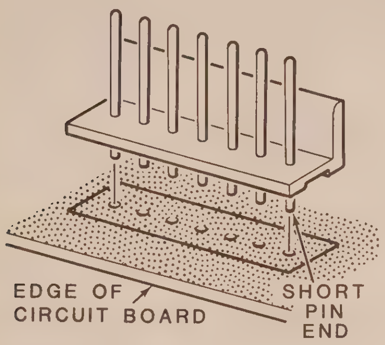
(✓) JP3: 2-pin plug. Solder the plug pins to the foil.

(✓) Solder the leads to the foil and cut off the excess lead lengths.

Refer to Pictorial 1-4 for the following steps.

Section 1

(✓) J4: 7-pin plug. Install the plug with the ridge as shown and solder the pins to the foil.



(✓) C1: 2200 μF electrolytic capacitor.

(✓) Y1: 7.3728 MHz crystal (#404-657).

(✓) C12: 100 μF electrolytic capacitor.

(✓) C3: 470 μF electrolytic capacitor.

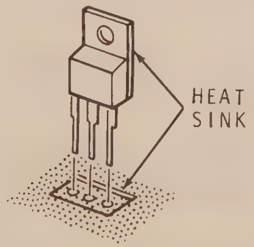
(✓) C5: 470 μF electrolytic capacitor.

NOTE: The following ICs look alike; therefore, do not confuse them in the next two steps. Make sure you use the correct part number.

R (✓) U22: 7812 IC (#442-674). Install this and the following IC with the bare metal side toward the double line shown on the circuit board. Insert the leads into the board holes until the lead shoulders are against the board. Then bend the leads out slightly to hold the IC in place.

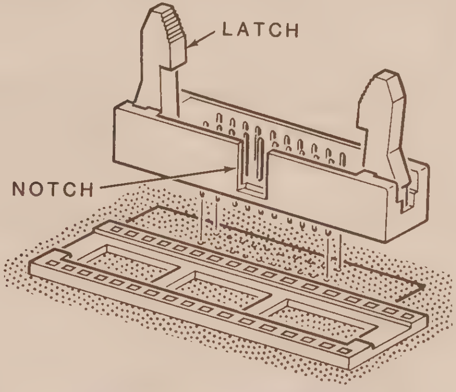
R (✓) U23: 7912 IC (#442-675).

(✓) Solder the leads to the foil and cut off the excess lead lengths.



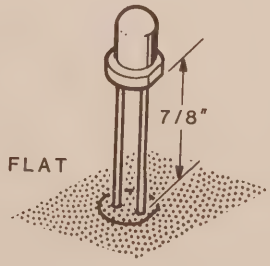
Section 2

(✓) J5: Install the 20-pin latching connector on the circuit board with the single notch positioned as shown. Keep the latch flat against the circuit board and solder it to the board in the same manner as you did with the other sockets. Discard any hardware that may have been supplied with the latch.



(✓) C14: 330 μF electrolytic capacitor. First, solder only the positive capacitor lead to the circuit board foil. Refer to the inset drawing on Pictorial 1-4 and wrap the longer lead of resistor R76 around the negative lead of this capacitor. Then cut off any excess lead lengths.

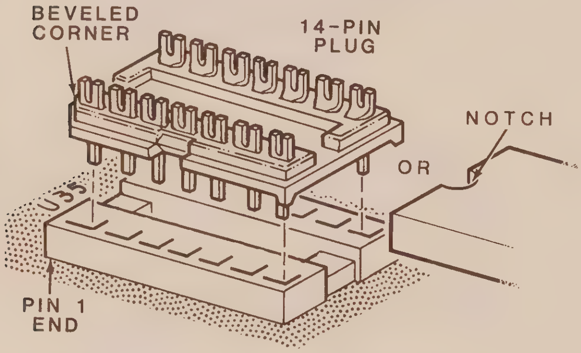
(✓) D8: Install an LST5053 LED (#412-640) at D8 with the case flat over the flat shown on the circuit board. Position the case bottom 7/8" above the board and carefully solder the leads to the top (component side) of the board. Do not use any more heat or solder than necessary to make a secure connection. When the solder cools, turn the board over and solder the leads to the foil side of the board. Cut off the excess lead lengths on the foil side of the board.



Use the previous procedure and install seven LST5053 LEDs (#412-640) on the circuit board at the following locations. Remember to position each case flat correctly.

( ) D7.
( ) D2.
( ) D1.
( ) D6.
( ) D5.
( ) D4.
( ) D3.

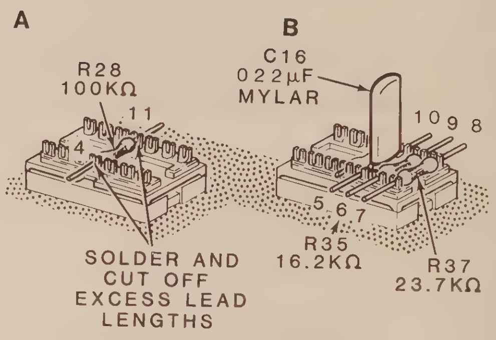
(✓) Install a 14-pin plug in IC socket U35. Position the socket with the pin 1 end (beveled edge) over the "1" shown on the circuit board. Make sure that none of the pins are bent and that all go into their socket holes properly.



(✓) Similarly install a 16-pin plug at IC socket U34.

(✓) Similarly install a 16-pin plug at IC socket U30.

NOTE: You will connect the remaining taped components that you set aside earlier, along with several Mylar capacitors (not part of the taped components), to the 14- and 16-pin plugs that you just installed. When you connect a component to the plug pins, lay the component body between the indicated pins so the leads fit into the pin notches. Then carefully solder the leads to the pins as shown above in Part A. You will have to form the capacitor leads to fit into the pins as shown in Part B. Cut off the excess lead lengths after you solder them to the pins. Do not use more heat than necessary to make the connections or you could damage the plug or IC socket. Also, be careful not to form a solder bridge between the closely spaced pins.



Connect components to plug U35 as follows:

You will not install components between pins 1 and 14, 2 and 13, or 3 and 12.

(✓) R28: 100 kΩ (brn-blk-yel) resistor between pins 4 and 11.

(✓) C16: .022 μF (223K) Mylar capacitor between pins 5 and 10.

(✓) R35: 16.2 kΩ, 1% (brn-blu-red-red) resistor between pins 6 and 9.

(✓) R37: 23.7 kΩ, 1% (red-org-viol-red) resistor between pins 7 and 8.

Connect components to plug U34 as follows:

You will not install a component between pins 1 and 16.

(✓) C22: .022 μF (223K) Mylar capacitor between pins 2 and 15.

(✓) R47: 22.1 kΩ, 1% (red-red-brn-red) resistor between pins 3 and 14.

(✓) R46: 47.5 kΩ, 1% (yel-viol-grn-red) resistor between pins 4 and 13.

(✓) C20: .0047 μF Mylar capacitor between pins 5 and 12.

(✓) C21: .0022 μF (222K) Mylar capacitor between pins 6 and 11.

( ) R45: 100 kΩ, 1% (brn-blk-blk-org) resistor between pins 7 and 10.

(✓) R44: 510 kΩ (grn-brn-yel) resistor between pins 8 and 9.

Connect components to plug U30 as follows:

(✓) R58: 37.4 kΩ, 1% (org-viol-yel-red) resistor between pins 1 and 16.

(✓) R57: 10 kΩ, 1% (brn-blk-blk-red) resistor between pins 2 and 15.

( ) R56: 16.2 kΩ, 1% (brn-blu-red-red) resistor between pins 3 and 14.

(✓) R55: 10 kΩ, 1% (brn-blk-blk-red) resistor between pins 4 and 13.

(✓) R52: 63.4 kΩ, 1% (blu-org-yel-red) resistor between pins 5 and 12.

(✓) R54: 10 kΩ, 1% (brn-blk-blk-red) resistor between pins 6 and 11.

( ) R53: 57.6 kΩ, 1% (grn-viol-blu-red) resistor between pins 7 and 10.

(✓) R51: 10 kΩ, 1% (brn-blk-blk-red) resistor between pins 8 and 9.

(✓) Cut the lead you set aside earlier to 1″.

(✓) Insert one end of the 1″ lead into hole TP1 on the circuit board.

(✓) Form a small loop at the other end of the 1″ lead.

CIRCUIT BOARD CHECKOUT

Carefully inspect the circuit board for the following problems.

(✓) Unsoldered connections.

(✓) Poor solder connections.

(✓) Solder bridges between foil patterns.

(✓) Protruding leads which could touch together.

(✓) Check transistors for the proper type and installation.

(✓) Check diodes for the proper type and positioning of the banded end.

(✓) Check electrolytic capacitors for the correct position of the positive (+) or negative (−) mark.

(✓) Check LEDs for the proper position of the case flat.

JUMPER SOCKET CONFIGURATION

Refer to Pictorial 1-5 for the following steps.

Install jumper sockets over the following plugs.

(✓) Plug JP7 pins 2 and 3.

(✓) Plug JP8 pins 1 and 2.

(✓) Plug JP6 pins 1 and 2.

(✓) Plug JP4 pins 1 and 2.

(✓) Plug JP1 pins 1 and 2.

Install jumper sockets over the following pins of latch J5. Push the latch arms together so you can install sockets over the end pins:

(✓) Pins 1 and 2.
( ) Pins 5 and 6.
( ) Pins 7 and 8.
( ) Pins 9 and 10.
( ) Pins 11 and 12.
( ) Pins 13 and 14.
( ) Pins 17 and 18.
( ) Pins 19 and 20.

NOTE: There are no sockets at pins 3 and 4 or 15 and 16.

This completes the circuit board assembly. Set it aside until it is called for later. Also set the remaining wire and sleeving aside.

CHASSIS

PARTS LIST

Remove the remaining parts from the carton and check each part against the following list. The key numbers correspond to the numbers on the "Chassis Parts Pictorial". Return any part that is in an individual envelope back into the envelope after you have identified it, until that part is called for in a step. Do not throw away any packing material until you account for all the parts.

To order a replacement part, always include the PART NUMBER. Use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover of this Manual. For prices, refer to the separate "Heath Parts Price List."

METAL PARTS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
A1	90-1341-1	1	Cabinet top
A2	200-1486-2	1	Chassis
A3	206-1497	1	Shield

HARDWARE

NOTE: The hardware is shown full size so you can place any nut, screw, etc. over the drawing. Also, the hardware may be packed in more than one envelope. Open all of the envelopes (marked HDW) before you check the hardware against the Parts List.

#6 Hardware

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
B1	250-1280	7	6-32 x 3/8" black phillips screw
B2	250-1331	9	6-32 x 5/8" black phillips screw
B3	252-3	17	6-32 nut
B4	253-2	2	#6 fiber shoulder washer
B5	254-1	10	#6 lockwasher
B6	259-1	2	#6 solder lug

#8 Hardware

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
C1	250-1436	2	8-32 x 3/8" black phillips screw
C2	252-4	2	8-32 nut
C3	254-2	2	#8 lockwasher

Other Hardware

KEY No.	HEATH Part No.	QTY.	DESCRIPTION
D1	255-13	7	1/4" spacer
D2	255-74	2	1/32" spacer

CONNECTOR — SOCKETS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
E1	432-753	7	Spring connector	
E2	432-822	1	7-hole socket shell	
E3	432-1293	1	9-pin plug	S3
E4	434-189	1	Transistor socket	

INTEGRATED CIRCUITS

NOTE: Integrated circuits may be marked for identification in any one of the following four ways:

1. Part number.
2. Type number. (This refers only to the numbers and letters shown in **BOLD** print in the Parts List. Disregard any other numbers or letters shown on the IC.)
3. Part number and type number.
4. Part number with a type number other than the one shown.

CAUTION: Integrated circuits can be easily damaged by static electricity. DO NOT remove any ICs from their foam pads until you are instructed to do so in a step.

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
F1	442-21	2	MC**1458**	U20, U31
F2	442-30	1	UA**309**	U24
F1	442-53	1	**555**	U26
F1	442-710	1	**2206** CP	U19
F1	442-779	1	**MF10**	U28
F1	442-780	1	**2211** CP	U18
F1	443-728	1	**74LS00**	U3
F1	443-755	1	**74LS04**	U1
F1	443-794	1	MC**1488** or **75188**	U15
F1	443-795	1	MC**1489** or **75189**	U16
F1	443-797	1	**74LS10**	U36
F1	443-891	1	**74LS86**	U32
F1	443-967	2	DM**7406N**	U21, U25
F1	443-973	1	**74LS393**	U2
F1	443-1014	1	**68A21**	U13
F1	443-1111	1	**6809**	U5
F1	443-1138	1	**6264**	U7
F1	443-1259	1	**6522**	U6
F1	443-1260	1	**6551**	U14
F1	443-1261	1	**1935**	U17
F1	443-1263	1	**2212**	U27
F1	444-349	1	*	U9
F1	444-350	1	*	U10
F1	444-351	1	*	U11
F1	444-352	1	*	U12
F1	444-353	1	**74S288, 18S030, 6331**, or **27S19**	U4

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* Programmed EPROM available from Heath Company.

MISCELLANEOUS

KEY No.	HEATH Part No.	QTY.	DESCRIPTION	CIRCUIT Comp. No.
G1	21-72	2	.005 µF/1.4KV ceramic capacitor	C65, C66
G2	54-1045	1	Power transformer	T1
G3	75-736	1	Strain relief	
	89-54	1	Line cord	
G4	61-49	1	Rocker switch	SW1
	75-817	1	Insulating paper	
G5	261-44	4	Foot	
G6	352-13	1	Silicone grease	
G7	390-1255	1	Fuse replacement label**	
G8		1	Blue and white label**	
G9	390-1855	1	FCC label**	
G10	421-20	1	1/2-ampere slow-blow fuse	F1
G11	431-609	1	Terminal strip w/fuse clips	
G12	475-35	1	RF core	
G13	354-5	3	Cable tie	
G14	6-561-12	1	560 Ω (grn-blu-brn-gld) 1/4-watt, 5% resistor	R59

** Located inside the Assembly Manual.

STEP-BY-STEP ASSEMBLY

Refer to Pictorial 2-1 for the following steps.

( ) Position the chassis upside down on your work surface. Remove the backing paper from the feet and install a foot at each of the chassis bottom corners. Keep the feet approximately 1″ from each edge of the chassis and do not cover any of the mounting holes.

(✓) Position the chassis as shown in the Pictorial.

(✓) Note the area around chassis holes A and J and the holes for T1. If there is any paint overspray around these holes, scrape it away with the blade of a screwdriver.

(✓) Mount a #6 solder lug to the chassis at hole A with a 6-32 × 3/8″ black phillips screw and a 6-32 nut. Position the lug toward hole K as shown.

(✓) Position the terminal strip w/fuse clips as shown in the Pictorial and, using a pair of diagonal cutters, cut off lug 5.

(✓) Mount the terminal strip w/fuse clips to the chassis at B with a 6-32 × 3/8″ black phillips screw, two #6 lockwashers, and a 6-32 nut. Position the terminal strip as shown.

(✓) Mount 6-32 × 5/8″ black phillips screws, #6 lockwashers, and 6-32 nuts to the chassis at C, D, E, F, G, H, and J.

Refer to inset drawing #2 for the next two steps.

(✓) Shorten the bare wire ends of the two yellow, two green, and green-black power transformer leads to 1/8″ and prepare the ends with a small amount of solder.

(✓) Crimp and solder spring connectors on the five prepared 1/8″ power transformer lead ends.

Insert the spring connectors on the power transformer leads into the 7-hole socket shell as follows:

(✓) Either yellow lead into hole 1.

(✓) Other yellow lead into hole 2.

(✓) Green-black lead into hole 4.

(✓) Either green lead into hole 5.

(✓) Other green lead into hole 6.

(✓) T1: Mount the power transformer to the chassis at T1 with two 8-32 x 3/8″ black phillips screws, two #8 lockwashers, and two 8-32 nuts. Position the transformer with the leads as shown.

(✓) SW1: Position the rocker switch with the lugs as shown and press it into the chassis at SW1 until the tabs lock into place.

(✓) Refer to Detail 2-1A and prepare the line cord leads as shown.

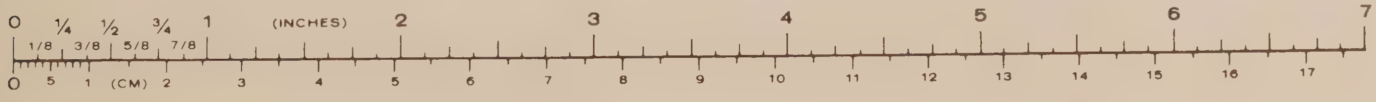
(✓) Refer to Detail 2-1B and mount the line cord and strain relief to the rear of the chassis at hole K. Allow a 3-1/2″ length of the line cord inside the chassis as shown.

NOTE: When you are instructed to prepare a wire, as in the following step, cut it to the indicated length and remove 1/4″ of insulation from the ends. Then twist the fine wire strands tightly together and apply a **small** amount of solder to the wire strands to hold them together.

(✓) Prepare two 5″ black wires. Shorten one 1/4″ prepared end of the two black wires to 1/8″.

(✓) Refer to inset drawing #2 and crimp and solder a spring connector on the 1/8″ prepared end of both 5″ black wires.

(✓) Position the 7-hole socket shell with the slots as shown on the Pictorial. Position the spring connector on one of the 5″ black wires with the locking tab facing the socket slot and insert it into socket hole 7 until the tab locks into place. Gently pull on each of the wires to make sure they have locked securely.



( ) Similarly insert the spring connector on the other 5″ black wire into socket shell hole 3.

( ) Locate the UA309 (#442-30) IC and its socket and note that the pins and socket holes are offset. Press the IC pins into the socket holes. Once installed, remove the IC from the socket and set the socket aside momentarily.

( ) Make a small cut in the silicone grease container.

NOTE: The silicone grease you will use in the next step is not caustic. However, keep the grease away from your eyes and wash your hands after you use it. Keep this and all chemicals out of the reach of children.

( ) Spread a thin even coating of the silicone grease on the flat side of the IC as shown. Discard the remaining grease.

( ) U24: Place the IC socket on the inside of the chassis at U24 so the socket and chassis holes align and the socket shoulders seat into their mounting holes. While you hold the socket in place, push the IC to the socket and press it against the outside of the chassis. Make sure the socket shoulders are still seated and secure the IC with two 6-32 × 5/8″ black phillips screws. Do not overtighten the screws.

( ) Place a 1/4″ spacer over each screw at C, D, E, F, G, H, and J.

( ) Position the circuit board assembly as shown and install it onto the seven screws and spacers. Secure the circuit board with seven 6-32 nuts and a #6 solder lug at screw location C. Position the solder lug as shown.

( ) Refer to inset drawing #1 and use long-nosed pliers to bend the eight LEDs over so that the ends of the cases fit into the front chassis holes as shown. When you bend the LEDs, be careful not to stress the connections or allow the leads to touch together.

Refer to Pictorial 2-2 for the following steps.

( ) Cut two 3/4″ pieces of heat-shrinkable sleeving. Set both pieces aside until they are called for in a step.

( ) Prepare the following black wires:

7″
3″

NOTES:

1. In the following steps, (NS) means not to solder because other wires will be added later. "S-" with a number following it, such as (S-3), means to solder the connection. The number three tells you that there are three wires and/or leads in the connection.

2. When you connect the wires and leads in the following steps, make the connections mechanically secure as shown in inset drawing #1 on the Pictorial.

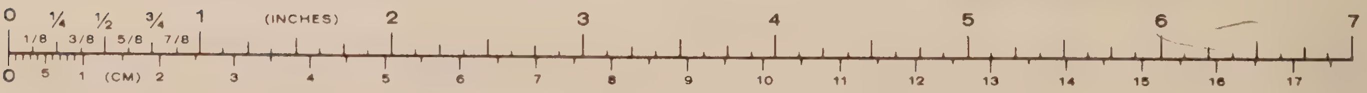
( ) Connect one end of the 7″ black wire to switch SW1 lug 1 (S-1). Slide one 3/4″ piece of heat-shrinkable sleeving over the free end of this wire and over the switch lug. Then, using a lighter or match, shrink the sleeving over the lug.

( ) Connect the other end of the 7″ black wire to terminal strip B lug 4 (S-1). Route the wire as shown.

( ) Connect one end of the 3″ black wire to solder lug C (S-1) and the other end to the tab on socket U24 (S-1).

( ) Slide the remaining 3/4″ piece of heat-shrinkable sleeving over either black power transformer lead. Connect this lead to switch SW1 lug 2 (S-1). Slide the sleeving over the switch lug and, using a lighter or match, shrink the sleeving over the lug.

( ) Connect the other black power transformer lead to terminal strip B lug 1 (NS).


0 ¼ ½ ¾ 1 (INCHES) 2 3 4 5 6 7
1/8 3/8 5/8 7/8
0 5 1 (CM) 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17

(✓) Connect the black wire coming from hole 3 of the 7-hole socket to IC socket U24 lug 1 (S-1).

(✓) Connect the black wire coming from hole 7 of the 7-hole socket to IC socket U24 lug 2 (S-1).

Connect the line cord leads as follows. Make sure the connections are mechanically secure.

( ) Green lead to chassis solder lug A (S-1). Form a loop in this lead as shown. NOTE: Do NOT shorten this wire.

(✓) Black lead to terminal strip B lug 2 (NS).

(✓) White lead to terminal strip B lug 1 (NS).

(✓) Cut four 1/2″ pieces of fiber sleeving.

Refer to inset drawing #2 of Pictorial 2-2 for the next three steps.

(✓) C66: Slide a piece of fiber sleeving over each lead of a .005 μF/1.4 kV ceramic capacitor. Then connect one capacitor lead to terminal strip B lug 2 (S-2) and the other lead to lug 3 (NS).

(✓) C65: Slide a piece of fiber sleeving over each end of the other .005 μF/1.4 kV ceramic capacitor. Then connect one capacitor lead to terminal strip B lug 1 (S-3) and the other lead to lug 3 (S-2).

(✓) F1: Snap the 1/2-ampere slow-blow fuse into the fuse clips of terminal strip B. Be careful not to break the terminal strip when you install the fuse.

(✓) Recheck all of the wire and lead connections at the terminal strip lugs to make sure they are all soldered securely.

(✓) Refer to Detail 2-2A and cut a 2-7/16″ × 1-1/2″ and a 1-1/8″ × 1-1/2″ piece of insulating paper from the insulating paper sheet. Discard the remaining paper.

(✓) Remove and discard the backing paper from each prepared piece of insulating paper and press it onto the bottom side of the shield at the indicated locations shown in Detail 2-2A.

(✓) Mount the shield over the terminal strip assembly with a 6-32 × 3/8″ black phillips screw, a #6 lockwasher, and a 6-32 nut. NOTE: The shield may touch against socket U24.

(✓) Write "1/2-ampere, slow-blow" on the fuse replacement label. Then remove the paper backing from the label and press it onto the top of the shield as shown.

(✓) Remove the paper backing from the blue and white label and press the label onto the bottom of the chassis at the indicated location. NOTE: Refer to the numbers on this label in any correspondence you may have with the Heath Company regarding this kit.

(✓) Read, date, and sign the FCC label. Then remove the paper backing and press the label onto the bottom of the chassis at the indicated location.

This completes the chassis assembly. Set the remaining parts aside and proceed to "Initial Tests."

NOTE: You will have a 560 Ω (grn-blu-brn) resistor left over. This resistor may be necessary if you use your TNC for HF or OSCAR operation.

INITIAL TESTS

PRIMARY WIRING CHECKS

A wiring error in the primary wiring circuit (transformer wiring, line cord, etc.) of your Terminal Node Controller could cause you to receive a severe electrical shock. These "Primary Wiring Checks" will assure you that no such wiring errors exist. NOTE: Do not plug in the line cord until you are instructed to do so in a step.

You will need a VOM (volt-ohmmeter), a VTVM (vacuum tube voltmeter), or a DMM (digital multimeter) to perform the resistance and voltage tests in this kit. If you do not have one of these meters, try to obtain one from a friend. It is important that you perform these tests. If you do not get the proper resistance or voltage readings, refer directly to the "In Case Of Difficulty" section on Page 6-1. DO NOT apply power to the unit if you do not obtain the correct resistance readings.

Refer to Pictorial 3-1 for the following steps.

NOTE: Most ohmmeters have a positive test voltage polarity ("+" input lead), while others have a negative test voltage polarity. If you do not obtain the correct readings, reverse the meter leads and make the measurement once more.

(✓) Set your meter to the R × 100 range.

(✓) Connect the common (−) ohmmeter lead to solder lug C.

(✓) Press the POWER switch to off.

(✓) Connect the positive (+) ohmmeter lead to either flat prong of the line cord plug. The meter should measure infinity (∞).

(✓) Press the POWER switch to on. The reading should be the same.

(✓) Connect the positive ohmmeter lead to the round prong on the line cord plug. The meter should measure 0 Ω.

(✓) Connect the positive ohmmeter lead to the other flat plug prong. Press the POWER switch to on and off. The meter should measure infinity for both settings.

(✓) Connect the positive ohmmeter lead to one flat line cord prong and the negative lead to the other flat line cord prong. The meter should measure infinity with the POWER off and between 40 and 90 ohms with the switch on.

(✓) Press the POWER switch to off.

This completes the "Primary Wiring Checks." Proceed to "Voltage Checks."

VOLTAGE CHECKS

Refer to Pictorial 3-1 for the following steps.

WARNING: You will apply power to your unit for the following tests. When the line cord is connected to an AC outlet, potentially hazardous voltages are present at several places. These areas are shown in the boxed-in areas on Pictorial 3-2. Be careful; if you touch these voltages, you will receive a severe electrical shock.

NOTE: If you experience any difficulties when you apply power to the unit, turn the power off and disconnect the line cord from the AC outlet immediately. Do not proceed with any further tests until you correct the problem.

( ) Connect the 7-hole socket coming from the power transformer to circuit board plug J4. The socket and plug are polarized to fit only one way.

( ) Make sure the POWER switch is off. Then connect the line cord plug to an AC receptacle.

( ) Connect the negative voltmeter lead to solder lug C.

( ) Press the POWER switch to on. Disregard any LEDs that may be lit.

NOTE: Use the positive voltmeter lead to make the following measurements.

(✓) Measure the **+5** volt bus for a reading of 5 volts DC (±.3 volt). 4.97

(✓) Measure the **+12** volt bus for a reading of +12 volts DC (±1.3 volts). 12.03

(✓) Measure the **−12** volt bus for a reading of −12 volts DC (±1.3 volts). 11.9

NOTE: Be careful when you measure the following IC voltages that you do not short the probe tip between adjacent IC pins.

(✓) Measure pin 7 of IC socket U28 for +5 volts DC. [illegible]

(✓) Measure pin 6 of IC socket U28 for −5 volts DC. [illegible]

( ) Switch the power off and disconnect the line cord from the AC outlet.

( ) Disconnect the voltmeter leads and set the meter aside.

( ) This completes the "Voltage Checks." Proceed to "IC Installation."

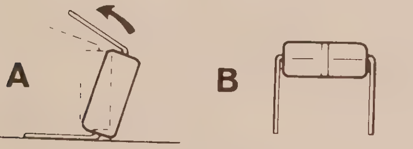
IC INSTALLATION

Refer to Pictorial 3-3 for the following steps.

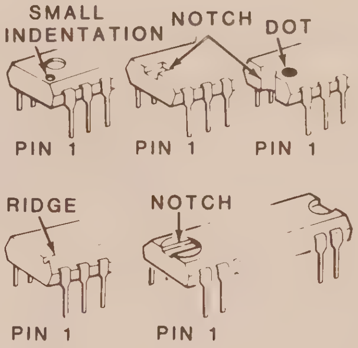
CAUTION: Integrated circuits (ICs) are complex electrical devices that perform many complicated operations in a circuit. These devices can be damaged during installation. Read all of the following information before you install the IC's.

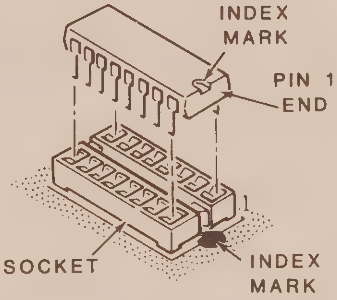
IMPORTANT: An IC packaged in conductive foam can be damaged by static electricity once you remove the IC. Once removed, do not lay the IC down or let go of it until you install it in its socket. When you bend the leads of the IC, hold it in one hand and place the other hand on the work surface before you touch the IC to that surface. This will equalize the static electricity between the work surface and the IC.

The pins on the ICs may be bent out at an angle as shown in A; if this is the case, they will not line up with the holes in the IC socket. Before you install an IC, lay it down on its side as shown in B and very carefully roll it toward the pins to bend the lower pins into line. Then turn the IC over and bend the pins on the other side in the same manner.

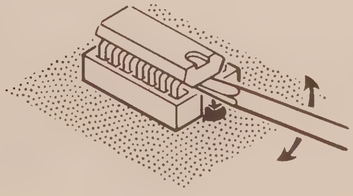


Before you install an IC, you must first identify the pin 1 end. Make sure this end of the IC is positioned over the index mark on the circuit board, as shown. Also make sure that all of the pins are started into the socket. Then press the IC firmly into the socket. NOTE: An IC pin can become bent under the IC and it will still appear as though it is correctly installed in the socket.





If it ever becomes necessary to remove an IC from its socket, insert the end of a screwdriver blade under the IC and gently move it up and down until the pins are free of the socket holes. Then carefully remove the IC.



Install ICs on the circuit board at the following locations:

Section 1

(✓) U1: 74LS04 IC (#443-755).

(✓) U5: 6809 IC (#443-1111).

(✓) U7: 6264 IC (#443-1138).

NOTE: You will not install an IC at location U8 at this time.

(✓) U2: 74LS393 IC (#443-973).

(✓) U4: 74S288, 18S030, 6331, or 27S19 IC (#444-353).

(✓) U3: 74LS00 IC (#443-728).

(✓) U14: 6551 IC (#443-1260).

(✓) U36: 74LS10 IC (#443-797).

(✓) U15: 1488 or 75188 IC (#443-794).

(✓) U16: 1489 or 75189 IC (#443-795).

Section 2

(✓) U9: 2764 IC (#444-349).

(✓) U10: 2764 IC (#444-350).

(✓) U11: 2764 IC (#444-351).

(✓) U12: 2764 IC (#444-352).

(✓) U13: 68A21 IC (#443-1014).

(✓) U17: 1935 IC (#443-1261).

(✓) U25: 7406 IC (#443-967).

(✓) U26: 555 IC (#442-53).

Section 3

(✓) U6: 6522 IC (#443-1259).

(✓) U27: 2212 IC (#443-1263).

(✓) U32: 74LS86 IC (#443-891).

(✓) U21: 7406 IC (#443-967).

(✓) U31: 1458 IC (#442-21).

(✓) U19: 2206 IC (#442-710).

(✓) U18: 2211 IC (#442-780).

(✓) U20: 1458 IC (#442-21).

(✓) U28: MF10 IC (#442-779).

(✓) Recheck each IC for the proper type and orientation of the pin 1 end.

This completes the "Initial Tests." Proceed to "Setup Instructions."

SET-UP INSTRUCTIONS

This section of the Manual gives you general information for connecting and setting up your Terminal Node Controller (TNC). A typical installation with a transceiver and a computer terminal is shown in Pictorial 4-1.

INTERFACING CABLES

Before you continue with the set-up instructions, first read the following information to decide what cables you need to interface your TNC with your data terminal (or computer) and your radio (transceiver or transmitter and receiver).

TERMINAL INTERFACE CABLE

A mating cable to interface your TNC and terminal is not included with your kit because so many different terminals with a nonstandard RS-232C serial port are available.

If your terminal (or computer with a terminal emulation program) has a "standard" RS-232C serial port using a DB-25 type 25-pin connector, you may either use an existing cable or make up one yourself. NOTE: If you are a computer hobbyist, you may already have a standard cable to interface to a modem. Since your TNC is configured to look like a standard modem at its serial port connector, you may use this cable. However, if you do not have such a cable, you may purchase one from the Heath Company. Refer to a current Heathkit catalog for this cable's Model Number and price.

If, however, you have a terminal that uses a nonstandard connector or uses some of its serial port pins for other purposes, you need to prepare a pin-for-pin cable with wires in at least positions 1 through 8 and 20, using a male connector for the TNC end and whatever type connector matches your terminal at the other end.

The Interconnection Chart (Illustration Booklet, Page 14) shows the interface signals required or produced at each pin of I/O connector J2 on the rear panel of the TNC. At the right of the chart are the pin numbers of a typical terminal I/O connector. In order to make the proper connections, perform the following steps.

(✓) Refer to your terminal manual (or computer manual and the documentation supplied with its software) to identify the signals into or out of its I/O connector. Then use a lead pencil to note those signals next to the terminal connector pin numbers on the chart.

(✓) Determine which pins of the terminal and TNC must be connected to each other. Then draw a line on the chart for each interconnection.

Refer to the drawing you just made and Pictorial 4-2 and prepare the terminal interface cable as outlined in the following steps.

( ) Cut the cable to a length sufficient to reach from your terminal to I/O connector J2 on the rear panel of your TNC. Allow enough extra length to be able to route the cable around and behind other equipment.

( ) Obtain a DB25P-type male connector and at least nine matching male connector pins for the TNC end of your cable. Also, if necessary, obtain a connector for the terminal end of the cable.

( ) Refer to Detail 4-2A Part A if you have a round cable, or Part B if you have a flat cable, and prepare the wire ends at one end of the cable. Crimp the tabs of a male connector pin and solder it to one of the wires at this end as shown in Detail 4-2B.

( ) Similarly, crimp and solder male connector pins to each of the remaining wires at this end of the cable.

( ) Install each wire by inserting the pin into the correct numbered hole of the male connector housing. Push on each wire until the pin locks into the hole.

( ) Connect the other end of the cable to your terminal. Either use an appropriate connector, or connect it directly, depending on the requirements of your equipment.

NOTE: You will connect the free end of the prepared terminal interface cable to your TNC later.

RADIO INTERFACE CHARACTERISTICS

The Heath TNC is designed for easy interfacing to your station transceiver (or transmitter and receiver). All radio input and output (I/O) is handled through a single 9-pin plug. A mating socket is provided with your TNC.

In general, you should have no problem interfacing your radio if it has the following common characteristics:

- All return lines are to negative ground.
- Separate microphone and PTT input lines are used.
- It exhibits clean audio sections with no spurious audio tones or audio harmonic distortion.

To provide proper audio response, a fixed resistor is programmed into input filter U28 of the TNC modem. This resistor value should be adequate for most receivers. However, you may have a "hard-case" unit requiring a different value. This is one reason that the input filter is configured via a 16-pin DIP header resistor pack (U30).

Due to the wide variety of audio input and output connectors in common use among amateur radio operators, the Heath Company cannot provide a prewired cable for mating to your particular radio. However, detailed connection information for a number of popular transceivers has been compiled on the separate "Hookup Instructions for Various Transceivers" provided with this kit. Please look for your particular radio there. If it is not listed there, please fill out the "Radio Interfacing Data Sheet" supplied with this kit and send it to the Heath Company.

The following explanation of the connector pinouts should help you to make up your own radio interface cable.

J3 Connector Pinouts

5? Ω mAR'

Pin 3 — Audio Input

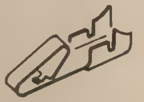
This line brings the audio from the radio to the TNC. It is normally connected to the headphone or speaker audio output of the receiver. The TNC input impedance, as normally configured, is about 10 kΩ, bypassed by .01 µF. If your receiver requires a lower impedance load, change C26 to 10 µF and install the 560 Ω resistor at R59 on the circuit board. Most radios do not require this resistor, even though they normally drive a low-impedance speaker.

N BOOKLET

Part of 595-3486

CTORIAL

F1



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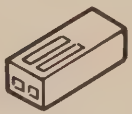

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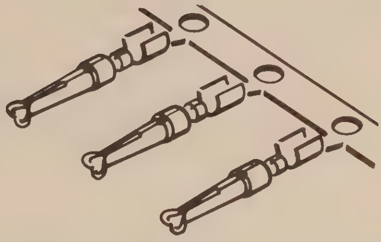

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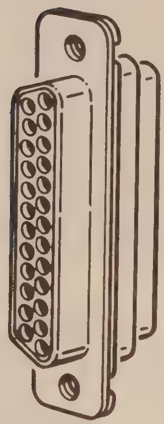

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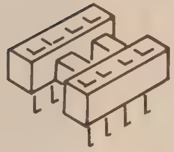

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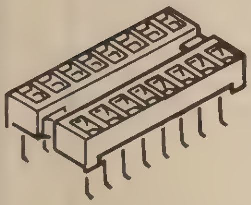

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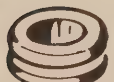

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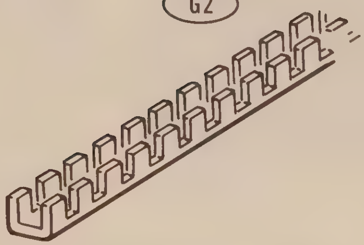

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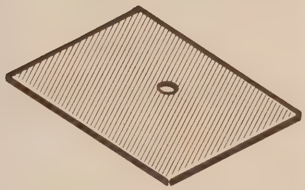

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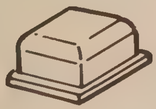

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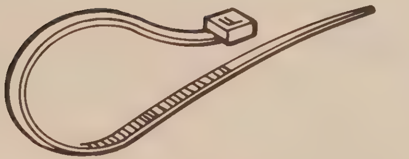

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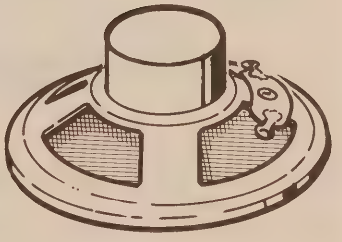

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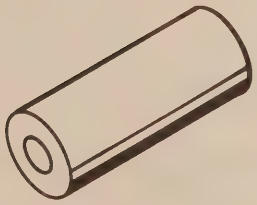

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Model HDA-4040-1

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Spkr mic

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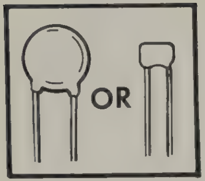
ILLUSTRATION BOOKLET

PARTS PICTORIAL

A1



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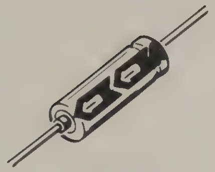

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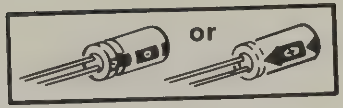

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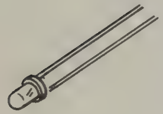

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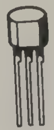

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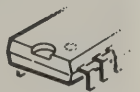

ALWAYS IDENTIFY AN I.C BY THE PART NUMBER OR THE TYPE NUMBER NOTE: THE STYLE MAY BE SLIGHTLY DIFFERENT THAN SHOWN.

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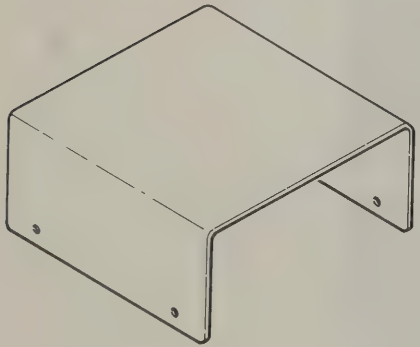

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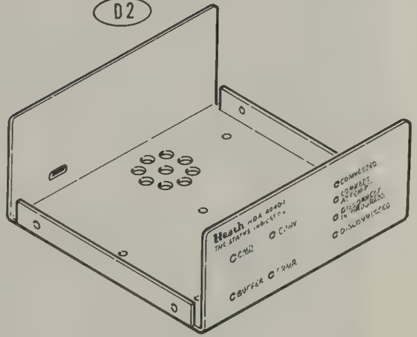

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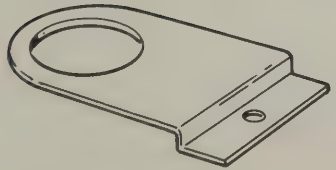

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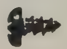

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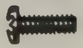

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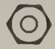

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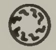

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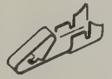

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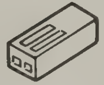

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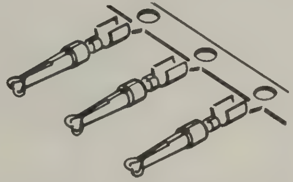

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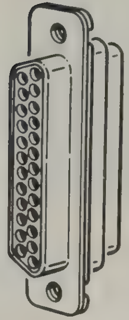

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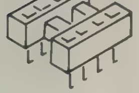

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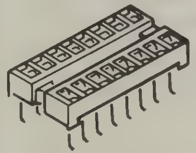

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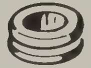

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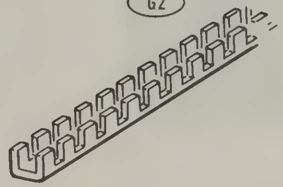

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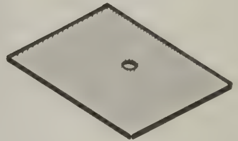

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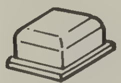

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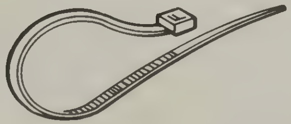

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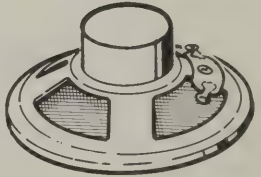
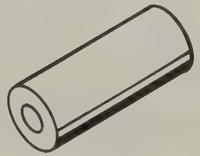


H4



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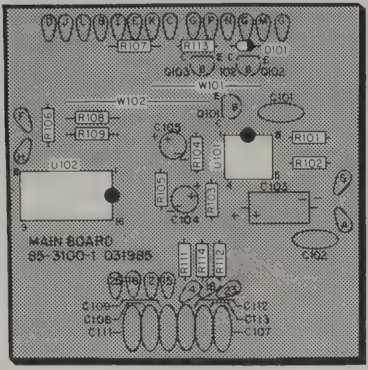
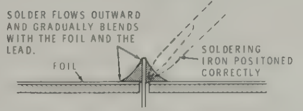


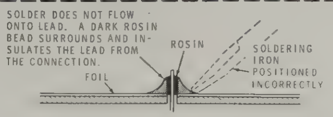
PICTORIAL 1-1

A GOOD SOLDER CONNECTION

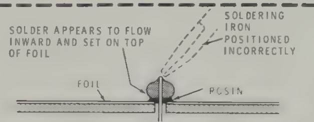

SOLDER FLOWS OUTWARD AND GRADUALLY BLENDS WITH THE FOIL AND THE LEAD.
FOIL
SOLDERING IRON POSITONED CORRECTLY

When you heat the lead and the circuit board foil at the same time, the solder will flow evenly onto the lead and the foil. The solder will make a good electrical connection between the lead and the foil.

POOR SOLDER CONNECTIONS


SOLDER DOES NOT FLOW ONTO LEAD. A DARK ROSIN BEAD SURROUNDS AND INSULATES THE LEAD FROM THE CONNECTION.
ROSIN
FOIL
SOLDERING IRON POSITIONED INCORRECTLY

When the lead is not heated sufficiently, the solder will not flow onto the lead as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.


SOLDER APPEARS TO FLOW INWARD AND SET ON TOP OF FOIL
SOLDERING IRON POSITIONED INCORRECTLY
FOIL
ROSIN

When the foil is not heated sufficiently the solder will blob on the circuit board as shown above. To correct, reheat the connection and, if necessary, apply a small amount of additional solder to obtain a good connection.

SOLDER BRIDGES

A solder bridge between two adjacent foils is shown in photograph A. Photograph **B** shows how the connection should appear. A solder bridge may occur if you accidentally touch an adjacent previously soldered connection, if you use too much solder, or if you "drag" the soldering iron across other foils as you remove it from the connection. A good rule to follow is: always take a good look at the foil area around each lead before you solder it. Then, when you solder the connection, make sure the solder remains in this area and does not bridge to another foil. This is especially important when the foils are small and close together. NOTE: It is alright for solder to bridge two connections on the same foil.

Use only enough solder to make a good connection, and lift the soldering iron straight up from the circuit board. If a solder bridge should develop, turn the circuit board foil-side-down and heat the solder between connections. The excess solder will run onto the tip of the soldering iron, and this will remove the solder bridge. NOTE: The foil side of most circuit boards has a coating on it called "solder resist." This is a protective insulation to help prevent solder bridges.

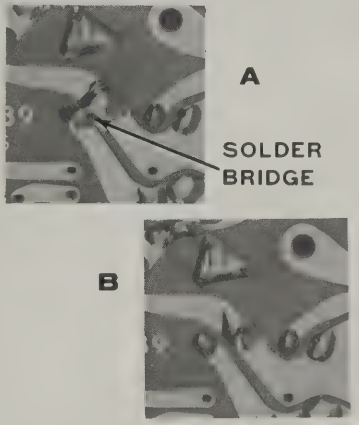
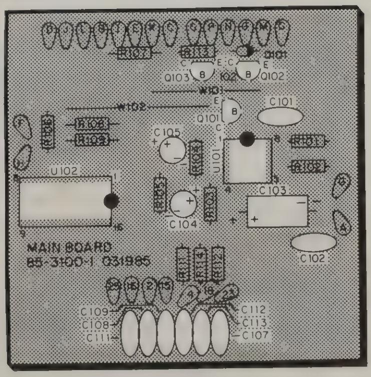


Figure 1



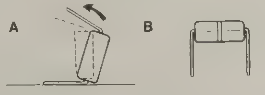
PICTORIAL 1-2

IC INSTALLATION

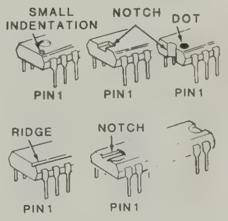
CAUTION: Integrated circuits (ICs) are complex electrical devices that perform many complicated operations in a circuit. These devices can be damaged during installation. Read all of the following information before you install the ICs.

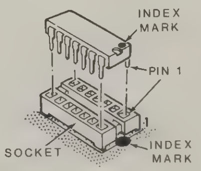
IMPORTANT: An IC packaged in conductive foam can be damaged by static electricity once you remove the IC. Once removed, do not lay the IC down or let go of it until you install it in its socket. When you bend the leads of the IC, hold it in one hand and place the other hand on the work surface before you touch the IC to that surface. This will equalize the static electricity between the work surface and the IC.

The pins of the ICs may be bent out at an angle as shown in A; if this is the case, they will not line up with the holes in the IC socket. Before you install an IC, lay it down on its side as shown in B and very carefully roll it toward the pins to bend the lower pins into line. Then turn the IC over and bend the pins on the other side in the same manner.



Before you install an IC, you must first identify the pin 1 end. Make sure this end of the IC is positioned over the index mark on the circuit board, as shown. Also make sure that all of the pins are started into the socket. NOTE: An IC pin can become bent under the IC and it will appear as though it is correctly installed in the socket.





If it ever becomes necessary to remove an IC from its socket, insert the end of a screwdriver blade under the IC and gently move it up and down until the pins are free of the socket holes. Then carefully remove the IC.

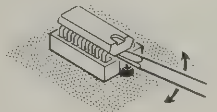
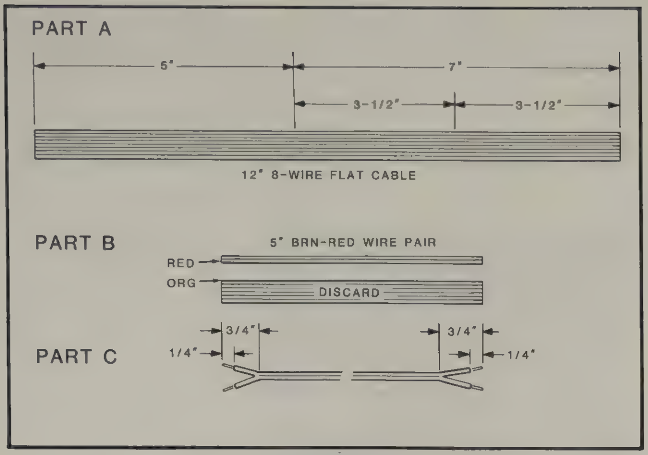
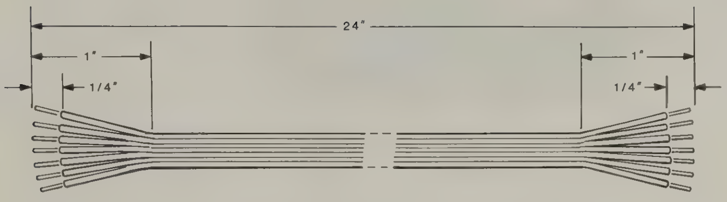


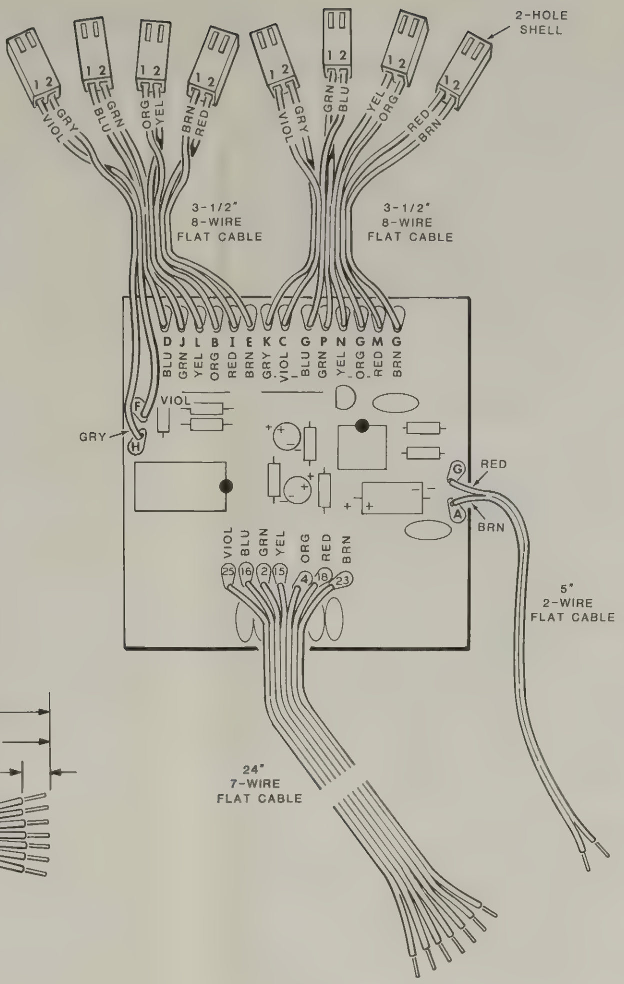
Figure 2



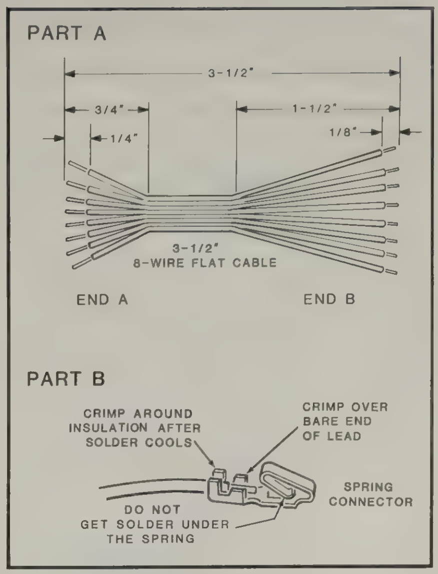
Detail 1-3A



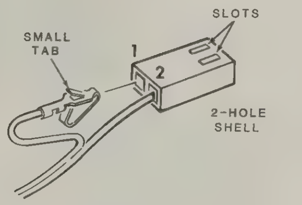
Detail 1-3D



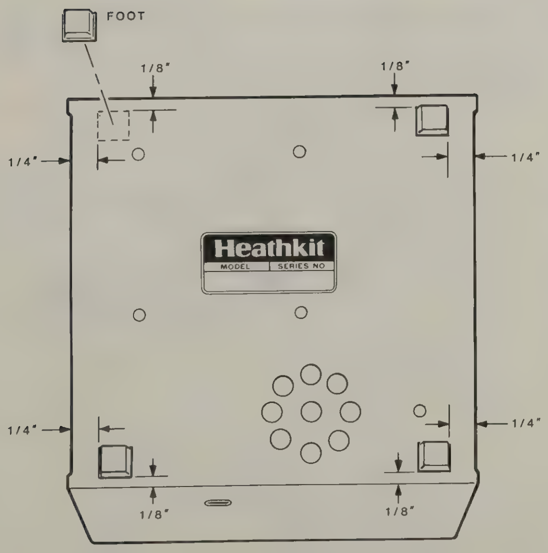
PICTORIAL 1-3


PART A
3-1/2"
3/4"
1-1/2"
1/4"
1/8"
3-1/2" 8-WIRE FLAT CABLE
END A
END B
PART B
CRIMP AROUND INSULATION AFTER SOLDER COOLS
CRIMP OVER BARE END OF LEAD
SPRING CONNECTOR
DO NOT GET SOLDER UNDER THE SPRING

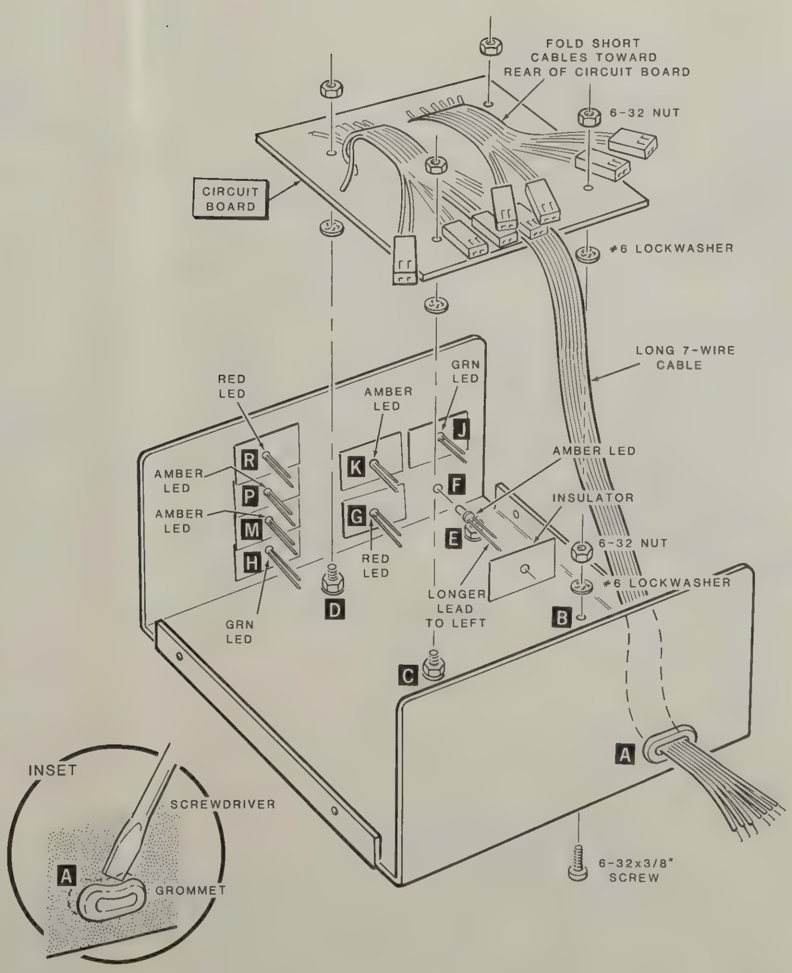
Detail 1-3B



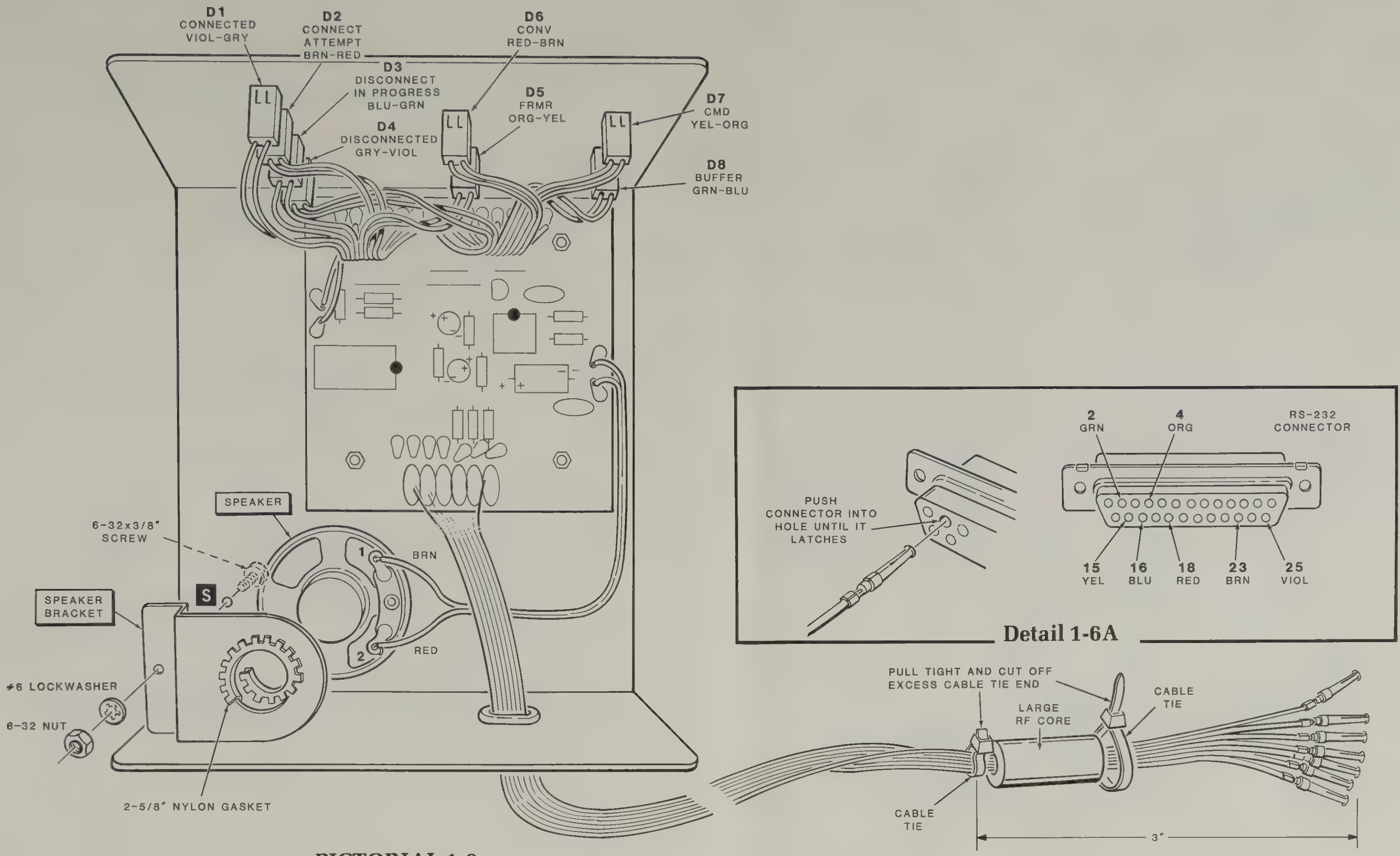
Detail 1-3C



PICTORIAL 1-4

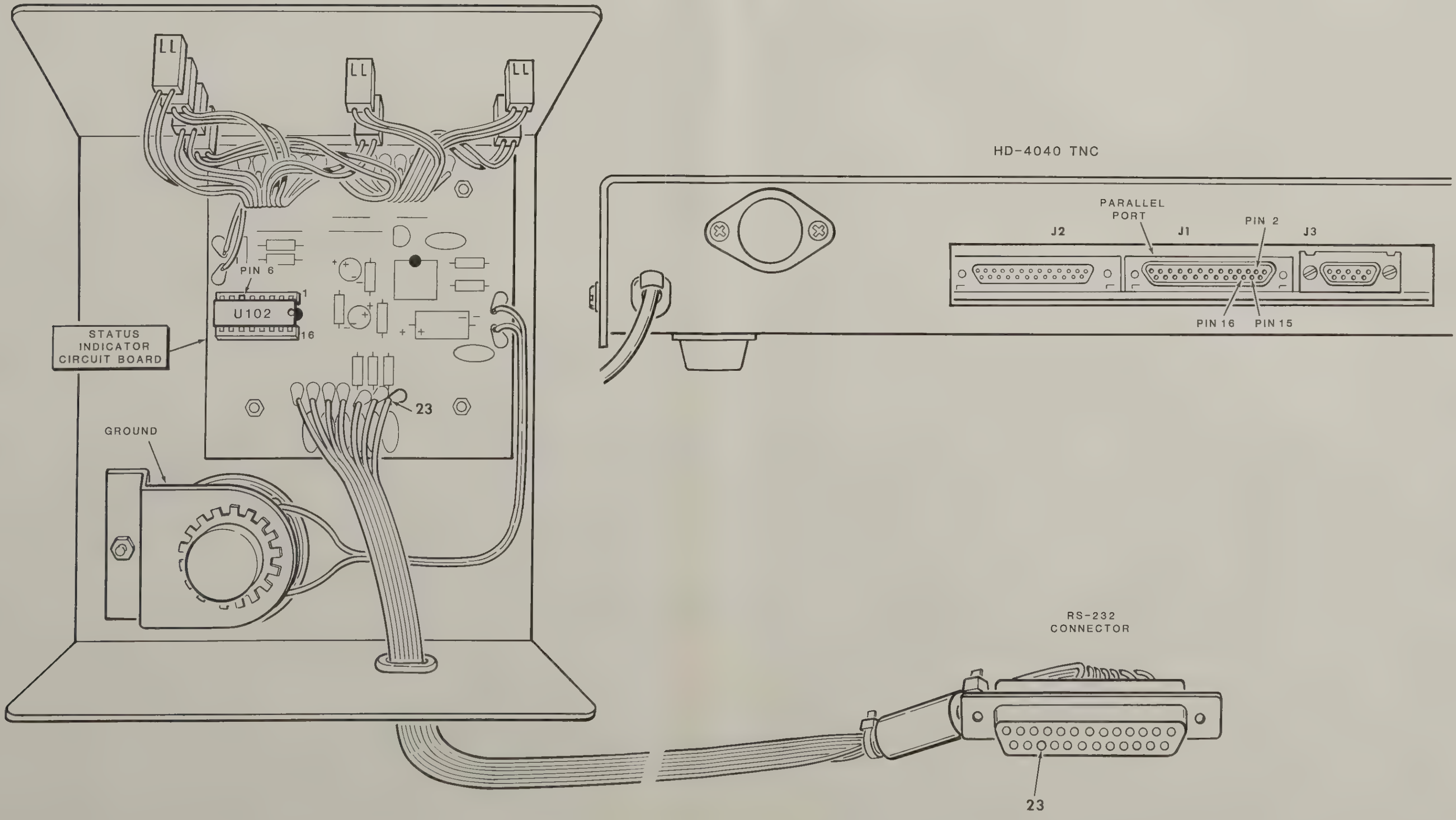


PICTORIAL 1-5

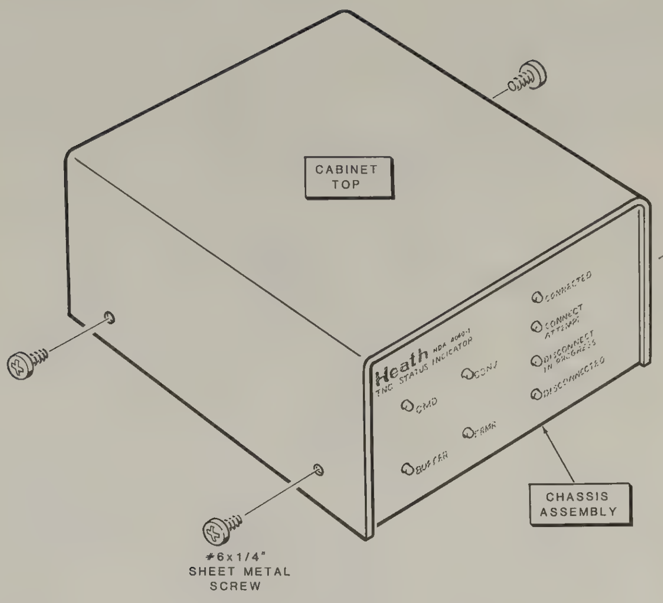


Detail 1-6A

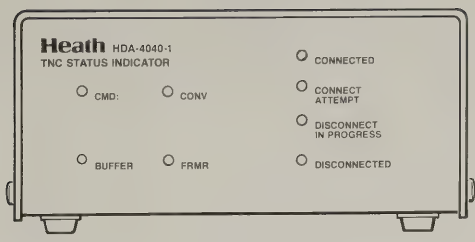
PICTORIAL 1-6



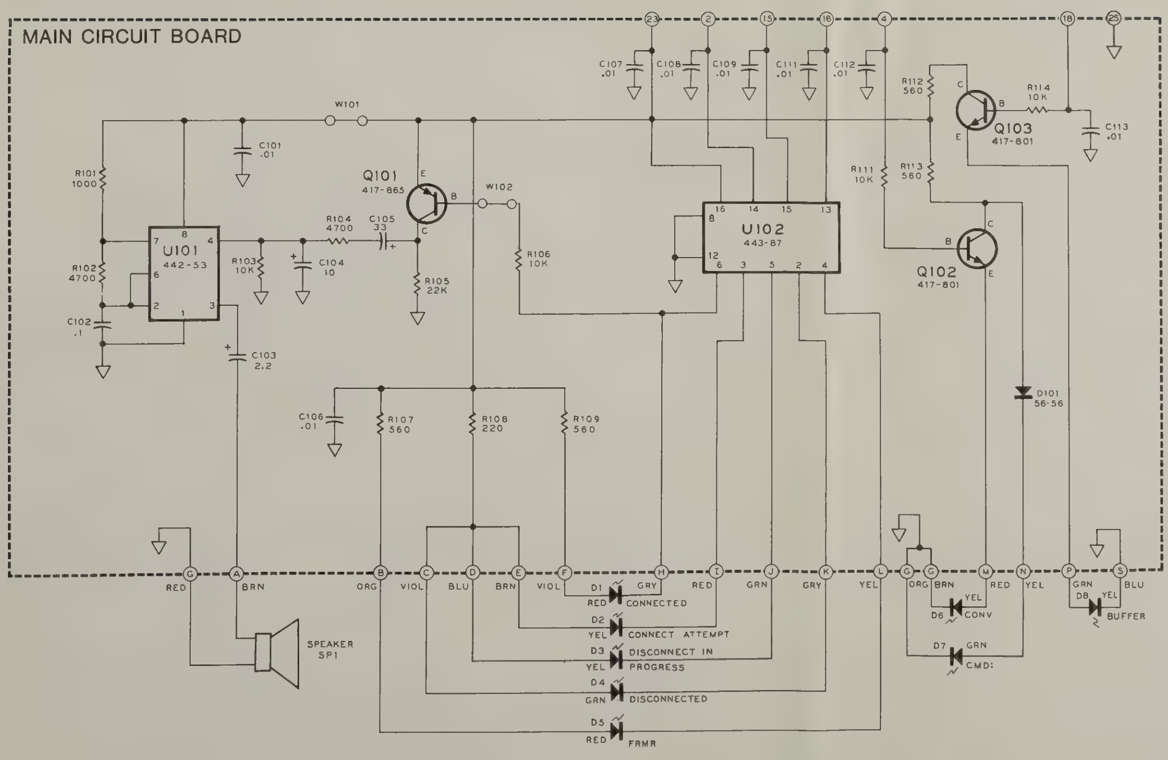
PICTORIAL 2-1



PICTORIAL 3-1



PICTORIAL 4-1



SCHEMATIC OF THE HEATHKIT® TNC STATUS INDICATOR MODEL HDA-4040-1

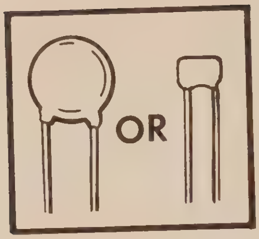
NOTES:

1. All resistors are rated at 1/4-watt, and have a 5% tolerance unless otherwise noted (K = 1000).
2. Capacitor values are in µF (microfarads).
3. The following symbols are used on this schematic diagram:
   - ▽ Circuit board ground.
   - Ⓐ (Lettered) A circuit board wire connection to a chassis-mounted component.
   - ⑱ (Numbered) A circuit board wire connecton to a like number on TNC parallel port P1.
   - ⬭ A DC voltage reading taken with a high input impedance digital voltmeter from the point indicated to chassis ground. Voltages may vary ±10%.
4. Refer to the "Circuit Board X-Ray View" on Manual Page 23 for the physical locations of parts.

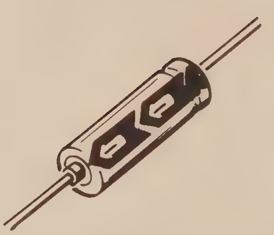
ILLUSTRATI

PARTS

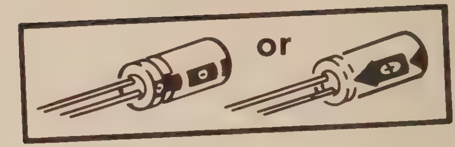
A1



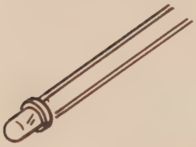
A2



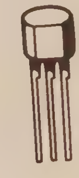
A3



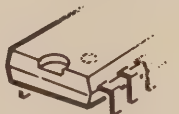
B1



C1

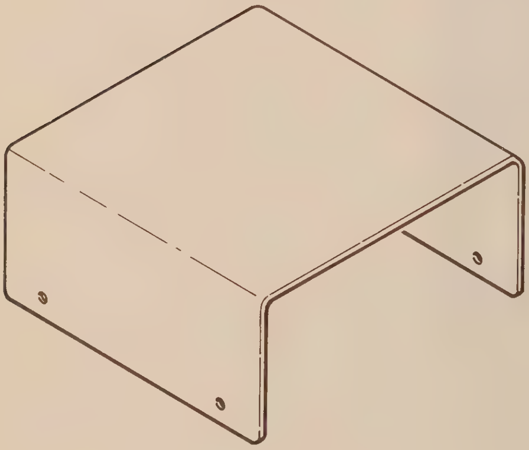


C2

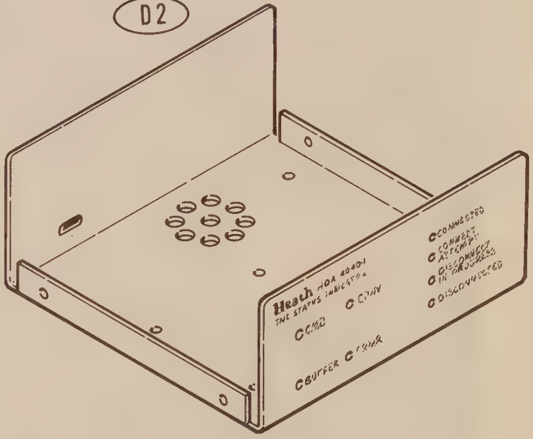


ALWAYS IDENTIFY AN I.C BY THE PART NUMBER OR THE TYPE NUMBER NOTE: THE STYLE MAY BE SLIGHTLY DIFFERENT THAN SHOWN.

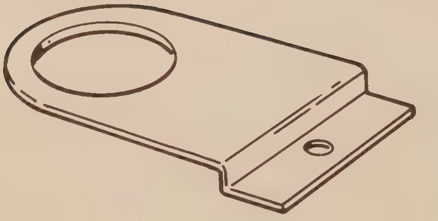
D1



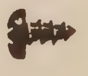
D2



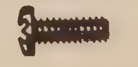
D3



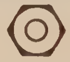
E1



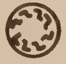
E2



E3



E4



Pin 4 — Transmit Key Line (PTT) 2

This line is used to connect to the PTT or other transmitter activation line on the attached radio. It will be connected to TNC common, or "ground," when the TNC attempts to key the transmitter. **The rating for this line is +30 VDC open circuit maximum, and 0 VDC open circuit minimum.** Do **NOT** connect it to a negative potential with respect to common. It can safely sink up to 250 mA in the closed (transmitter keyed) configuration. CAUTION: If the above ratings of the transmitter key line is exceeded, your TNC may be extensively damaged. If your radio fails to meet the above criterion, be sure to use a relay or other means for keying your transmitter.

IMPORTANT: BE SURE YOU KNOW THE PTT CHARACTERISTICS OF YOUR RADIO BEFORE CONNECTING YOUR TNC TO IT!

Pin 5 — Transmitter Audio

This lead provides an audio signal to the station transmitter microphone input.

The TNC audio output is AC-coupled through C19, a nonpolarized .1 μF electrolytic capacitor, OR a 1 μF polarized electrolytic capacitor (assembly option). If your radio has a microphone input impedance below about 3000 Ω, you should probably use the 1 μF capacitor. (CAUTION: Be aware of possible polarity reversal problems. The TNC side of the capacitor is at a potential of about 0 VDC). If your input impedance is above about 3000 Ω, you should use the .1 μF capacitor.

NOTE: Do not attempt to use the TNC to directly drive a so-called carbon microphone input circuit, as this is a low-impedance input that requires considerable drive current. While damage to your TNC is not likely, excessive distortion of the transmitted signal is probable, which will result in unreadable packet transmissions.

Pins 6 through 9 — Common 9
9

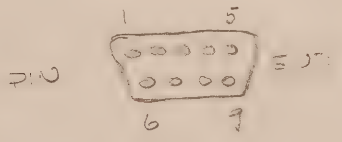
These pins are tied directly to the negative return bus on the TNC and should be connected to the negative return bus on the radio. This common serves as a return for transmit control (PTT) and both send and receive audio.

NOTE: Some Japanese HTs, such as the Yaesu FT-208R, use their positive supply bus as audio return. Do **NOT** connect this positive audio return to TNC common! Instead, connect the HT's negative common to the TNC. This should not cause any problems, as the radio's power supply should be adequately bypassed for audio.

TNC
J3

9PIN SOCKET
RADIO END.

ctr RED 3 AUDIO IN (SPKR) 2
WHT 4 PTT LINE TO GND
ctr GRN 5 TRANSM. AUDIO TO XMTR 7
BLK 6 NEG COMM - ⏚ CL
7 " " 3
8 " "
BLK 9 " "
1



PCS 3000

1 MIC GND. CHASSIS
2 CHASSIS GND
3 MIC AUDIO
4 PTT
5 13.8 V
6
7

Pin 4 — Transmit Key Line (PTT) 2

This line is used to connect to the PTT or other transmitter activation line on the attached radio. It will be connected to TNC common, or "ground," when the TNC attempts to key the transmitter. **The rating for this line is +30 VDC open circuit maximum, and 0 VDC open circuit minimum.** Do **NOT** connect it to a negative potential with respect to common. It can safely sink up to 250 mA in the closed (transmitter keyed) configuration. CAUTION: If the above ratings of the transmitter key line is exceeded, your TNC may be extensively damaged. If your radio fails to meet the above criterion, be sure to use a relay or other means for keying your transmitter.

IMPORTANT: BE SURE YOU KNOW THE PTT CHARACTERISTICS OF YOUR RADIO BEFORE CONNECTING YOUR TNC TO IT!

Pin 5 — Transmitter Audio

This lead provides an audio signal to the station transmitter microphone input.

The TNC audio output is AC-coupled through C19, a nonpolarized .1 μF electrolytic capacitor, OR a 1 μF polarized electrolytic capacitor (assembly option). If your radio has a microphone input impedance below about 3000 Ω, you should probably use the 1 μF capacitor. (CAUTION: Be aware of possible polarity reversal problems. The TNC side of the capacitor is at a potential of about 0 VDC). If your input impedance is above about 3000 Ω, you should use the .1 μF capacitor.

NOTE: Do not attempt to use the TNC to directly drive a so-called carbon microphone input circuit, as this is a low-impedance input that requires considerable drive current. While damage to your TNC is not likely, excessive distortion of the transmitted signal is probable, which will result in unreadable packet transmissions.

Pins 6 through 9 — Common 9
9

These pins are tied directly to the negative return bus on the TNC and should be connected to the negative return bus on the radio. This common serves as a return for transmit control (PTT) and both send and receive audio.

NOTE: Some Japanese HTs, such as the Yaesu FT-208R, use their positive supply bus as audio return. Do **NOT** connect this positive audio return to TNC common! Instead, connect the HT's negative common to the TNC. This should not cause any problems, as the radio's power supply should be adequately bypassed for audio.

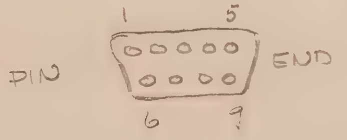
PCS 3000

1 MIC GND, CHASSIS
2 CHASSIS GND
3 MIC AUDIO
4 PTT
5 13.8 V
6
7

TNC
J3

9PIN SOCKET
RADIO END.

ctr RED 3 AUDIO IN (SPKR) 2
WHT 4 PTT LINE TO GND
ctr GRN 5 TRANSM. AUDIO TO XMTR 7
BLK 6 NEG COMM - ⏚
7 " " 3
8 " "
BLK 9 " "
1



RADIO INTERFACE CABLE

Refer to Pictorial 4-3 for the following steps.

NOTE: When you make the connections between your TNC and radio, use the shielded cable supplied with this kit. Be sure to keep the length of each cable less than four feet.

(✓) Cut two shielded cables to a length sufficient to reach from your radio to the 9-pin connector (J3) on the rear panel of your TNC.

(✓) Prepare each end of both cables as shown in Detail 4-3A. Then mark one of the cables by wrapping a small piece of masking tape or similar material around the middle of it.

(✓) Obtain a mating connector (or connectors) for your radio's microphone and headphone (or external speaker) jack(s).

(✓) Locate the 9-pin plug.

Connect and solder the leads at the free end of the **marked** cable to the 9-pin plug as follows:

- (✓) Center lead to pin 3.
- (✓) Shield lead to pin 7.

Connect and solder the leads at the free end of the unmarked cable to the 9-pin plug as follows:

- (✓) Center lead to pin 5.
- (✓) Shield lead to pin 9.

(✓) Cut a white wire to the same length that you cut the two shielded cables. Then prepare both wire ends.

(✓) Connect and solder one end of this wire to pin 4 of the 9-pin plug.

(✓) Slide a ferrite bead over the free end of both shielded cables and the white wire and against the 9-pin plug.

(✓) If you have the shell for your radio's headphone (or speaker) connector, slide it over the free end of the **marked** cable and the free end of the white wire. NOTE: Make sure you place the proper end of the shell over the cable and wire first.

(✓) Connect and solder the center lead at the free end of the **marked** cable to the audio output terminal of your radio headphone (or speaker) jack.

(✓) Connect and solder the shield wires at the free end of the **marked** cable to an audio common point. CAUTION: Do **NOT** use audio common if this point is at a positive potential with respect to your radio's power "ground."

(✓) If you have the shell for the microphone connector, slide it over the free end of the unmarked shielded cable and white wire. Again, make sure you place the proper end of the shell over the end of the cable first.

Connect and solder the leads at one end of the unmarked cable to your radio's microphone connector as follows:

(✓) Center lead to the audio input pin.

(✓) Shield lead to the microphone audio common pin. NOTE: This common **must** be at the same DC potential as the headphone (or speaker) audio common and DC power common.

(✓) Connect and solder the free end of the white wire to the PTT (push-to-talk) pin of your radio's microphone connector.

(✓) Inspect the "cable" that you just completed to make sure that all connections are properly made and soldered and no shorts exist.

(✓) Assemble the shell(s), if available, onto your microphone and headphone (or speaker) connectors.

(✓) Be sure the ferrite bead is still against the 9-pin plug. Then install a cable tie on the two cables and the white wire as shown in the Pictorial.

(✓) Similarly, install a cable tie around both cables and the white wire — one in the middle and one near the radio end to make a neat cable assembly. Then cut off any excess cable tie.

NOTE: You will connect the prepared radio interface cable later.

OPERATIONAL CHECKS

Refer to Pictorial 4-4 for the following steps.

(✓) Set each of the four sections of the DIP switch on the TNC circuit board as follows:

SW-1 – ON

SW-2 – ON

SW-3 – OFF

SW-4 – ON

( ) Connect the TNC line cord plug to an appropriate AC outlet.

NOTES:

1. If you do not obtain the proper results in the following steps, place the POWER switch in the off position, refer to the "In Case of Difficulty" section of this Manual, and correct any difficulties before you proceed.
2. After you successfully complete the following test, most ICs on the TNC circuit board will be exercised, the EPROMs will be read, and the digital circuitry is probably functional.

(✓) Switch the power on. LEDs D1 (RESET) and D6 (SPARE) should light. If LED D2 (CWID) also lights it will go out in one to two seconds. LED D2 may turn on one to two seconds after power is switched on. In this case it will stay on until a CWID is performed. NOTE: LED D3 (TXD) may or may not light.

(✓) Switch the TNC power off.

NOTE: Read the "Terminal Characteristics" section of the User's Manual before you proceed with the following steps.

(✓) Set the baud rate of your terminal to 300, if this has not already been done.

( ) Set the word length to 7 and parity to space, or the word length to 8 and parity to none.

( ) If you can set the number of stop bits, select 1.

( ) Connect the socket at the free end of the terminal interface cable to connector J2 of your TNC. CAUTION: Do not force the socket in place; it should press on snugly and remain in place. You may damage the connector or circuit board if you use excessive force.

( ) Switch the terminal power on and allow it to warm up for a couple of minutes.

( ) Switch the TNC power on. Its LEDs should flash and it should then send the following message to your terminal:

```
Please type an asterisk (*) for autobaud
routine
```

( ) As the autobaud message starts to appear on your terminal screen, press the * key. NOTE: If you allow the complete message to appear before you press the key, press it two more times with a duration of one half to two seconds between each key press. Then, if the autobaud message starts to appear again, press the * key **while the message is being typed on the screen.**

( ) If this message does not appear on the terminal screen, toggle reset switch SW-3 on and then off before you again press the * key. NOTE: If the message still does not appear, refer to the "In Case of Difficulty" section of this Manual.

The following message should now appear on your screen:

```
Heath Company Amateur Packet Radio
AX.25 level 2 version X.Y.*
RAM length is 2000
cmd:
```

* X.Y. denotes the software revision level.

NOTES:

1. The third line in the sign-on message indicates the number of "bytes" (in hexadecimal) that the software exercised and found operational on your TNC when it went through the power-up reset routine. The value $2000 (where $ indicates a hexadecimal number) is the same as 8192 (decimal) or "8K."

2. If the number appearing in the third line of the message is not "2000", either you have installed the RAM IC at U7 improperly or it may be defective.

(✓) If the sign-on message does not appear on the screen, try again by toggling reset switch SW-3 on and then off before you again press the * key.

MODEM CALIBRATION

Your Terminal Node Controller contains a versatile user-configurable FSK modem that you may use for both 1200 baud "Bell 202" packet operation as well as for lower data rates, such as 170 Hz shift 300 baud rate on HF links.

You will need the following test equipment as you calibrate your TNC:

- An oscilloscope.

or

- An AC voltmeter.

NOTES:

1. Although calibration of the modem in your TNC is not normally required after you have performed it once, you may wish to check the calibration if you find that you have difficulty communicating with other packet radio stations.
2. You may refer to this section in the future. However, ignore any messages instructing you to remove jumpers that you may not have installed on your TNC.
3. If you do not obtain the proper result in any of the following steps, place the POWER switch in the off position, refer to the "In Case of Difficulty" section, and correct any difficulties before you proceed.

DEFAULT TONES (BELL 202)

Refer to Pictorial 4-5 to locate the circuit board components referred to in some of the following steps.

(/) After the sign-on message appears on your terminal screen, type the following command on your keyboard:

```
CALIBRA <RETURN>
```

The following message should appear on your screen:

```
TNC Calibration and Checkout

Menu:
   1  Set low tone (1200 Hz)
   2  Set high tone (2200 Hz)
   3  Set demodulator (1700 Hz)
   4  Set audio level
      and tone null
   5  ROM checksum
   6  End calibration and reset

cal:
```

NOTES:

1. The prompt "`cal:`" means your TNC is in the calibration mode and is awaiting your command. To select any item on the menu, enter the number of the item in response to the prompt, followed by a RETURN. Your terminal screen will then display a message describing the jumper placement and adjustments you need to make.
2. Be sure to remove or place the jumper(s) as instructed in the text for each calibration step appearing on the screen.
3. An acceptable error count for each calibration step is 1 to 3. If necessary, repeat any step until the error count is less than 3.

( ) To calibrate the 1200 Hz tone, press 1 followed by RETURN.

The following text will appear on the screen:

```
cal:1

1 Set low tone (1200 Hz)
Remove jumpers JP1,JP3,JP4
Place jumpers JP2,JP5
Adjust R38
Type any key to continue
```

NOTES:

1. LEDs D1 (RESET) and D2 (CWID) are your frequency-setting indicators. When D2 is lit, the frequency is too low and you must turn the control (pot) screw counterclockwise. When D1 is lit, however, the frequency is too high and you need to turn the control screw clockwise. When both LEDs are lit, or they both flicker with about the same intensity, the control setting is just right.

2. Use a small screwdriver when you adjust each of the calibration controls. You may have to turn the adjustment screw of each control several complete revolutions before the control setting is correct because these controls are 25-turn (maximum) devices.

( ) Set the jumper sockets as instructed on the screen.

( ) Adjust control R38 until LEDs D1 and D2 light or flicker with about the same intensity. Then press any key on your terminal keyboard. Depending on how close you adjusted this control to the correct setting, the following message may (for example) appear on your screen:

```
Error is 0001 counts

cal:
```

( ) To calibrate the 2200 Hz tone, press 2 followed by RETURN.

The following text will appear on your screen:

```
cal:2


  2 Set high tone (2200 Hz)
Remove jumpers JP3,JP4,JP5
Place jumper JP2
Adjust R36
Type any key to continue
```

( ) Set the jumper sockets as instructed on the screen.

( ) Adjust control R36 until LEDs D1 and D2 flicker with about the same intensity. Then press any key on your terminal keyboard. Again, depending on how close you adjusted this control to the correct setting, the following message may appear on your screen:

```
Error is 0001 counts

cal:
```

( ) To calibrate the 1700 Hz tone, press 3 followed by RETURN.

The following text will appear on your screen:

```
cal:3

  3 Set demodulator (1700 Hz)
Remove jumpers JP1,JP2
Place jumper JP3
Adjust R43
Type any key to continue
```

( ) Set the jumper sockets as instructed on the screen.

( ) Adjust control R43 until LEDs D1 and D2 flicker with about the same intensity. Then press any key on your terminal keyboard. Depending on how close you adjusted this control to the desired setting, the following message may appear on your screen:

```
Error is 0001 counts

cal:
```

(✓) To set the audio level and tone null, press 4 followed by RETURN.

The following text will appear on your screen:

```
cal:4

  4 Set audio level
    and tone null
Remove jumpers JP2,JP3,JP5
Place jumpers JP1,JP4
Adjust R31 and R33
Type 'Q' to quit,'K' to key/unkey transmit-
ter,
any other key to switch tone
```

(✓) Set the jumper sockets as instructed on the screen.

(✓) Set control R31 to the end of its range by turning its adjustment screw clockwise until you hear a faint click from the control (maximum 25 turns).

(✓) Press K on the terminal keyboard. LED D4 (PTT) should light.

In the following steps, you will set the audio drive level needed to drive your transmitter. Note that the voltage level at test point TP1 will be about 30 times the level present at the audio output line from the TNC (at connector J3 pin 5).

(✓) Refer to the manufacturer's specifications for the recommended audio drive signal for your transmitter. NOTE: Use 20 mV peak-to-peak if this value is not available.

(✓) Multiply this value by 30 to obtain the desired voltage level at TP1. (Example: 20 mV × 30 = 600 mV or .6 V).

(✓) Using a calibrated oscilloscope, adjust control R33 for the desired peak-to-peak voltage at TP1 (.6 V in the example above). NOTE: If you are using an AC voltmeter, divide the desired voltage by 2.828 and adjust control R33 for that voltage (.2 V in the example) at TP1.

(✓) Press K again. LED D4 should go out.

( ) Slowly adjust control R31 counterclockwise for a null (minimum level) of the audio signal at TP1, as indicated by your oscilloscope or AC voltmeter. NOTE: This null is fairly sharp and very deep.

(✓) After setting the null, press the K key again several times while, at the same time, you observe that the audio drive signal switches between the preset level and the null. Also verify that LED D4 (PTT) is lit when the signal is present and off when the signal is nulled out.

(✓) Press the Q key on the terminal keyboard.

(✓) Disconnect the test equipment.

(✓) To verify that the EPROMs are correct, press 5 followed by RETURN.

The following text will appear on your screen:

```
cal:5

   5 ROM checksum
8000 nnnn   ABA[illegible]
A000 nnnn   [illegible]
C000 nnnn   ACD9
E000 nnnn   6B33
cal:
```

The software determines these checksum values by adding all the bytes in each EPROM. The software release notes, if any, accompanying your software may also contain a list of these checksums to allow you to verify that your EPROMs are valid.

NOTE: The value "nnnn" above simply means a 4-digit hexadecimal number, which can mean any value of 0 through 9 or A, B, C, D, E, or F. The use of "nnnn" should not be taken to mean that the checksums for all four EPROMs are the same; this is not very likely.

( ) After viewing the checksums, press 6 followed by RETURN.

Your PRNC will respond with the following message:

```
cal:6

   6 End calibration and reset
Remove jumpers JP2,JP3,JP5
Place jumpers JP1,JP4
Type any key to continue
```

(✓) Be sure the jumper sockets are placed as stated on the screen.

(✓) Switch the power to your TNC off.

NON-DEFAULT TONES

The TNC calibration system also allows you to set tone frequencies other than the default frequencies in case you wish to experiment. A typical example might be to use 170 Hz shift at 300 baud and slower speeds for HF operation. Of course, you may want to modify the passband characteristics of the MF-10 modem filter to optimize performance at a shift different from the default. It may also be necessary to alter the values of some of the timing and filtering components in the modulator, demodulator, and/or watchdog timer to use other data rates successfully. For these reasons, many modem components are mounted on DIP headers U30, U34, and U35 instead of simply being soldered to the TNC circuit board.

The calibration system measures a tone's frequency by counting the number of system clock cycles that occur in two oscillations of the waveform being measured. Since the system clock runs at 921.6 kHz, it "ticks" once each 1.085 μs. This count is compared with a 16-bit counter value, and the software then commands the LEDs to indicate whether the period just measured was too long or too short. The error-count message is the residual count "overflow" on the last period measured. Thus, an error of "0001 counts" means the measured period was 1.085 μs too long, corresponding to a frequency about 3/4 Hz low in the case of the 1200 Hz tone.

In order to calibrate the modem to a different tone pair, you must first calculate twice the period of each frequency to be measured. As you probably know, the period is the reciprocal of the frequency (1/f). For example, a frequency of 2975 Hz, widely used in HF AFSK work, has a period of 1/2975 = 336.1 μs. Our measuring interval is twice this period, or 2 * 336.1 = 672.2 μs.

The next step is to determine how many CPU clock cycles occur in the measuring interval. With a CPU clock frequency of 921.6 kHz, each clock cycle is 1.085 μs long. Again, using 2975 Hz as the reference (which we will continue to use throughout this discussion), there are 672.2/1.085 = 619.5 clock cycles in the measurement interval. Since the counter used can only work in terms of integers, we round this result to the nearest integer, giving a value of 620.

When you enter the CALIBRA (calibrate) command and then select option 2, you must enter the new count value that you want the software to use. In the example, you enter the value 620 as follows:

```
cal:2/620
```

The "/" tells the software to look for the new number you are supplying in place of its normal one.

In the same manner, you may calculate values for the modulator low tone and the free-running VCO frequency of the XR2211 demodulator. Note that the 2211's VCO frequency should be the average of the high and low tones for best operation (the default 1700 Hz is midway between 1200 Hz and 2200 Hz).

If the TNC will not calibrate to your new tones, but calibrates properly to its defaults, this probably means that you must change a component value on the DIP header (U34 or U35) associated with the adjustment you are trying to make. To reduce the frequency limits of an adjustment, increase the value of the resistor in series with the control you are adjusting, or lower the value to increase the frequency limits. Note that 1% temperature-stable resistors are used, along with zero drift capacitors, in your TNC modem. Do **not** use typical 5% carbon resistors or other than "COG" (NPO) coefficient capacitors in the modem's frequency-determining components. Otherwise, you may experience some very annoying calibration drift.

EQUIPMENT HOOK-UP

( ) Make sure the power to your radio is off.

( ) Connect the 9-pin plug at one end of your audio interface cable to connector J3 on the rear panel of your TNC. CAUTION: Do not force the plug in place; it should press on snugly and remain in place. You may damage the connector or circuit board if you use excessive force.

( ) Connect the microphone and headphone connectors at the free end of the radio interface cable to your radio.

( ) Switch on the power to both your TNC and radio.

(✓) Turn your radio's squelch control until it is fully open. Then turn its volume control until the REC AUDIO LEDs on your TNC just barely flicker. IMPORTANT: To be assured of reliable packet radio communication, **do NOT turn the volume control up too high; otherwise, the TNC circuitry may be overloaded.**

(✓) Switch off the power to both your TNC and radio.

BAUD RATE OPTIMIZATION

At this point, your TNC and terminal (or computer) are transferring data between them at a rate of 300 baud (default value). You may soon find, however, that this rate is too slow for you, and therefore you wish to increase it.

If you are using a terminal, you may select a transfer rate as high as 19200 baud. With a computer using a terminal emulator program, on the other hand, you are limited to a maximum rate of 4800 baud if you plan to transfer any files.

For instructions on how to change the baud rate for either your terminal or computer, refer to the Operation Manual for this equipment. After returning your TNC to the command mode, you may change the baud rate to 4800 baud (for example) by typing:

```
cmd: ABAUD 4800 <RETURN>
```

(12C

Then save this information by typing:

```
cmd: PERM <RETURN>
```

This writes the new baud rate into NOVRAM so it will be set automatically the next time you power up your TNC. Set switch SW-1 to the off position so the TNC will use the NOVRAM information instead of the default value. NOTE: Do a "soft reset" after resetting SW-1 by typing:

```
cmd: R <RETURN>
```

NOTE: At this point, your TNC will no longer communicate with your terminal (or computer) until you change to the new (faster) baud rate.

This completes the "Set-Up Instructions" for your Terminal Node Controller. Proceed to "Final Assembly."

1-5-86

FINAL ASSEMBLY

Refer to Pictorial 5-1 for the following steps.

(✓) Position the unit with its front panel towards you as shown.

(✓) Use the following procedure to mount the cabinet top to the unit:

1. Place the cabinet top over the unit with the two larger mounting holes in the cabinet top towards the rear of the unit.
2. Secure the rear of the cabinet top to the unit with two 6-32 × 3/8″ phillips head screws, two #6 fiber flat washers, and two 1/32″ spacers. Make sure the shoulder of each washer is towards the cabinet.
3. Secure the front of the cabinet top to the unit with two 6-32 × 3/8″ phillips head screws.

NOTE: If it ever becomes necessary for you to get inside the TNC, you may do so without completely removing the cabinet top from the unit. Simply remove the two screws that secure the front of the cabinet top to the unit. You can then swing the front of the cabinet top up and out of the way.

This completes the assembly of your Terminal Node Controller. Proceed to the "Operation" section in the User's Manual, where you will be guided through the initialization procedure for your completed TNC, and then place your packet station on the air.

IN CASE OF DIFFICULTY

Begin your search for any trouble that occurs after assembly by carefully following the steps under "Visual Tests" below. Then, if this does not help you find the trouble, refer to the "Troubleshooting Chart". If you are a qualified technician, you can use the "Voltage Chart" for further help in locating a problem.

You may find it helpful to refer to the Schematic Diagram and Circuit Description as you trace the circuit to locate the cause of the problem. Refer to the "Circuit Board X-Ray View" for the physical locations of parts on the circuit board.

VISUAL TESTS

1. Recheck the assembly steps. Mark each step with a colored pencil on the Pictorial as you check it. You may also wish to have someone else check your work. Someone who is not familiar with the unit may notice something that you have consistently overlooked.

2. About 90% of the kits that are returned to the Heath Company for repair do not function properly due to poor connections and soldering. Therefore, you can eliminate many troubles by reheating all of your connections to make sure they are soldered as described on Page 1-6 of this Manual. Be sure there are no solder "bridges" between circuit board foils.

3. Check to be sure that the transistors and all diodes are properly installed in their correct locations. Make sure that each diode is positioned with its banded end over the band mark on the circuit board.

4. Check each electrolytic capacitor to be sure its positive (+) or negative (−) mark is at the correct location.

5. Check to be sure that each IC is properly installed, and that the pins of the dual-in-line devices are not bent out or under the IC. Also be sure the ICs are installed in their correct locations.

6. Check to see that each part you installed on the Pictorials has the correct value. It would be easy, for example, to mistake a 22 kΩ (red-red-orange) resistor for a 2200 Ω (red-red-red) resistor.

7. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.

8. Look between the circuit board and the chassis to be sure all leads were cut off short.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of this Manual. Your Warranty is located inside the front cover.

TROUBLESHOOTING CHART

The following chart lists conditions and possible causes of several specific malfunctions. If a particular part (Q1, for example) is mentioned as a possible cause, check that part to see that it is installed and/or soldered correctly. It is also possible, on rare occasions, that a part may be faulty and require replacement. In that case, refer to "Replacement Parts" printed inside the rear cover of this Manual.

SYMPTOM	POSSIBLE CAUSE
1. No LEDs are lit.	A. Fuse F1. B. Power switch SW5. C. Power transformer T1.
2. No +12 V.	A. Diodes D9, D10. B. IC U22. C. Capacitor C3.
3. No −12 V.	A. Diodes D11, D12. B. IC U23. C. Capacitor C5.
4. No +5 V.	A. Diodes D13 through D16. B. IC U24. C. Capacitor C1.
5. No sign-on message after power turn-on.	A. ICs U1, U2. B. Crystal Y1. NOTE: To determine if the time-base oscillator is operating, check for about 2 VAC at U2, pin 10 (using a high input-impedance VTVM).
6. No sign-on message after power turn-on. However, LEDs D1 (RESET), D6 (SPARE), and D2 (CWID) are lit.	A. Cable connections to terminal. B. IC U5.
7. No sign-on message after power turn-on; only a single character or random letters displayed.	A. Switch SW1 in the NOVRAM (off) position, and no memory in U27.
8. Unit cannot be calibrated.	A. IC U19. B. Circuit board jumper sockets improperly installed.
9. Transmitter will not key.	A. Transistor Q1. B. IC U26.
10. Transmitter is keyed continuously.	A. Diode D19. B. Transistor Q1.
11. Cannot communicate with other stations.	A. The baud rate of your unit does not agree with that of the other station(s).
12. Cannot receive signals from other stations.	A. Receiver audio level is too strong or too weak. NOTE: Be sure that LEDs D7 and D8 (REC AUDIO) only light faintly.
13. Other stations cannot copy your signals. However, you copy theirs okay.	A. Transmit tone levels too high or too low. NOTE: Repeat steps under "Modem Calibration." Also recheck manufacturer's recommended microphone input level for your equipment.

DIAGNOSTIC AND STATUS SIGNALS

During normal operation, parallel user port J1 is used to output diagnostic and status signals. The status signals are provided for use by bulletin board programs or other computer-based applications.

The diagnostic signals represent interrupts to the microprocessor from its various peripheral chips. These signals are updated as the processor actually services the interrupts instead of waiting for the interrupts to be generated by the hardware. The signal in each case is **toggled** from low to high or high to low upon servicing the interrupt. Thus, for example, if you look at the timer interrupt signal with an oscilloscope, you should see a square wave with a period of 20 ms, since the timer interrupt is generated at 10 ms intervals.

The following diagnostic signals are present:

J1 PIN NUMBER	DESIGNATION	INTERRUPT SIGNAL
19	PB0	U14 (terminal) input
6	PB1	U14 (terminal) output
20	PB2	U6 timer
7	PB3	U17 carrier-detect change
12	PB4	U17 XEOM with error
11	PB5	U17 XEOM without error
10	PB6	U17 REOM with error
9	PB7	U17 REOM without error

The five U17 interrupt signals correspond to interrupts on pin 6 of this IC. XEOM means "transmitted end of message". The only error possible for a transmitted message is an underrun condition, which could occur if the data rate is too high for the processor or if many other interrupt requests are present. The XEOM-with-error condition should never occur during proper operation of the TNC. REOM means "received end of message". The errors possible for received messages are: overrun, which like the underrun condition, should never occur; aborted or invalid frame, which is frequently present if there is random noise on the channel; and frame-check sequence error, which occurs if a genuine packet is received in error.

NOTE: Two of the interrupt signals from U17 are not represented in the list above. These signals are DRQI (data request for input) on pin 18 and DRQO (data request for output) on pin 19.

The status signals are provided for possible use by a computer attached to the TNC. The signals provided are shown below.

J1 PIN NUMBER	DESIGNATION	STATUS SIGNAL
15	PA0	\
2	PA1	Link state
16	PA2	/
4	PA5	Operating mode
18	PA6	Active packet buffer
5	PA7	Carrier Detect

The link state is represented by a number from 1 to 5 in binary appearing on pins 15, 2, and 16. The possible link states are:

PIN 16	PIN 2	PIN 15	LINK STATE
0	0	1	Disconnected
0	1	0	Connect attempt in progress
0	1	1	FRMR condition detected
1	0	0	Disconnect in progress
1	0	1	Connected

The significance of these link states is described in the "Protocols" section of the User's Manual. Note that you may regard pin 16 as a connect indication, similar to the modem carrier-detect that a telephone bulletin-board program might use.

Pin 4 indicates that the TNC is in the command mode (1) or data mode (0). Pin 18 indicates that the radio transmit buffer is active, meaning that not all packets which have been generated have been transmitted. Pin 5 is a copy of the state-of-the-audio carrier detect, which is also indicated by the DCD LED (D5).

VOLTAGE CHART

Voltage measurements in your TNC should be made only by a skilled technician or a person experienced in servicing electronic equipment containing semiconductors and integrated circuits.

This chart lists the correct voltages at various points on the circuit board and on the chassis of your TNC. All measurements were made using a high input-impedance voltmeter with a 15-volt scale from the indicated point to chassis. Your voltages may vary; however, they should be within ± 10% of those listed.

Refer to Pictorial 6-1, to the Schematic Diagram (fold-in), and the Circuit Board X-Ray View for the location of the test points listed. Touch your voltmeter test probe **ONLY** to the test point. Do **NOT** let it slip and touch or short against other points. Unless your tests probe has a very slender tip, you may want to attach a short piece of #22 wire to its tip.

Before you start making voltage measurements on your TNC, be sure to:

1. Switch the TNC power on.
2. Select the Command Mode with the default conditions.
3. Disconnect all external connections to connectors J1, J2, and J3 on the rear panel of the TNC.

SPECIFICATIONS

Processor	6809.
Clocks	7.3728 MHz crystal oscillator supplies clock signals to UART, switched-capacitors filter, and E & Q systems.
Memory	ROM, 32K = 4 × 2764. RAM, 8K = 1 × 6264. Expandable from 2K to 16K, RAM or ROM.
Serial Port	RS-232C interface to terminal or computer. Baud rates 50 to 4800 (optional to 19,200).
Parallel Port	Controller status and command channel, diagnostic signal port, and PROM programmer port.
Modem	Input is filtered prior to demodulation. Filter constant is changed by plug-in header. Modulator operates to 1200 baud. External modem plugs in to completely bypass internal modem for higher baud rates.
NOVRAM	Stores the operating commands. Battery backup is not required. 128 4-bit locations.
Protocols	AX.25 and VADCG.
Operating Modes	Command — configures controller. Conversation — used for communications. Transparent — used in digital contacts.

Power	120V, 15 watts.
Operating Temperature	0° C to + 40° C (32° F to 104° F) ambient.
Overall Dimensions	13-5/8″ W × 7-3/4″ D × 2-3/8″ H (34.6 × 19.7 × 6.0 cm)
Net Weight	3 lbs, 8 oz (1.6 kg).

◆

The Heath Company reserves the right to discontinue products and change specifications at any time without incurring any obligation to incorporate new features in products previously sold.

SCHEMATIC OF THE
HEATHKIT®
TERMINAL NODE CONTROLLER
MODEL HD-4040

NOTES:

1. ALL RESISTORS ARE 1/4-WATT, 5% AND ARE MARKED IN OHMS (k-1,000; M-1.000,000).

2. ALL CAPACITORS ARE IN µF (MICROFARADS) UNLESS STATED OTHERWISE.

3. ○ INDICATES A WIRE CONNECTION ON THE CIRCUIT BOARD.

4. ⏚ INDICATES CHASSIS GROUND.

5. ▽ INDICATES CIRCUIT BOARD GROUND.

6. >— INDICATES A FEMALE (SOCKET) CONNECTION.

7. → INDICATES A MALE (PLUG) CONNECTION.

8. ╋● INDICATES A CONNECTION POINT.

9. ┼ INDICATES A NO CONNECTION POINT.

10. **J6-1** INDICATES SOCKET AND PIN NUMBER.

11. NUMBERS SUCH AS **(1)** OR **8** NEXT TO A COMPONENT INDICATES A PIN NUMBER.

12. { ✱—— U30 16 PIN PLUG.
✱✱ — U34 16 PIN PLUG.

Power	120V, 15 watts.
Operating Temperature	0° C to + 40° C (32° F to 104° F) ambient.
Overall Dimensions	13-5/8″ W × 7-3/4″ D × 2-3/8″ H (34.6 × 19.7 × 6.0 cm)
Net Weight	3 lbs, 8 oz (1.6 kg).

* * *

The Heath Company reserves the right to discontinue products and change specifications at any time without incurring any obligation to incorporate new features in products previously sold.

SCHEMATIC OF THE HEATHKIT® TERMINAL NODE CONTROLLER MODEL HD-4040

NOTES:

1. ALL RESISTORS ARE 1/4-WATT, 5% AND ARE MARKED IN OHMS (k-1,000; M-1.000,000).
2. ALL CAPACITORS ARE IN µF (MICROFARADS) UNLESS STATED OTHERWISE.
3. ○ INDICATES A WIRE CONNECTION ON THE CIRCUIT BOARD.
4. ⏚ INDICATES CHASSIS GROUND.
5. ▽ INDICATES CIRCUIT BOARD GROUND.
6. ≻— INDICATES A FEMALE (SOCKET) CONNECTION.
7. → INDICATES A MALE (PLUG) CONNECTION.
8. ✦ INDICATES A CONNECTION POINT.
9. + INDICATES A NO CONNECTION POINT.
10. **J6-1** INDICATES SOCKET AND PIN NUMBER.
11. NUMBERS SUCH AS **(1)** OR **8** NEXT TO A COMPONENT INDICATES A PIN NUMBER.
12.
    - ✱ — U30 16 PIN PLUG.
    - ✱✱ — U34 16 PIN PLUG.
    - ✱✱✱ - U35 14 PIN PLUG.
13. PARTS IN SHADED AREAS IN THE POWER SUPPLY'S PRIMARY CIRCUIT ARE CRITICAL FOR CONTINUED SAFETY. REPLACE THEM ONLY WITH PARTS OF THE SAME RATING OR WITH THE PROPER HEATH PARTS.

Part of 595-3334-01

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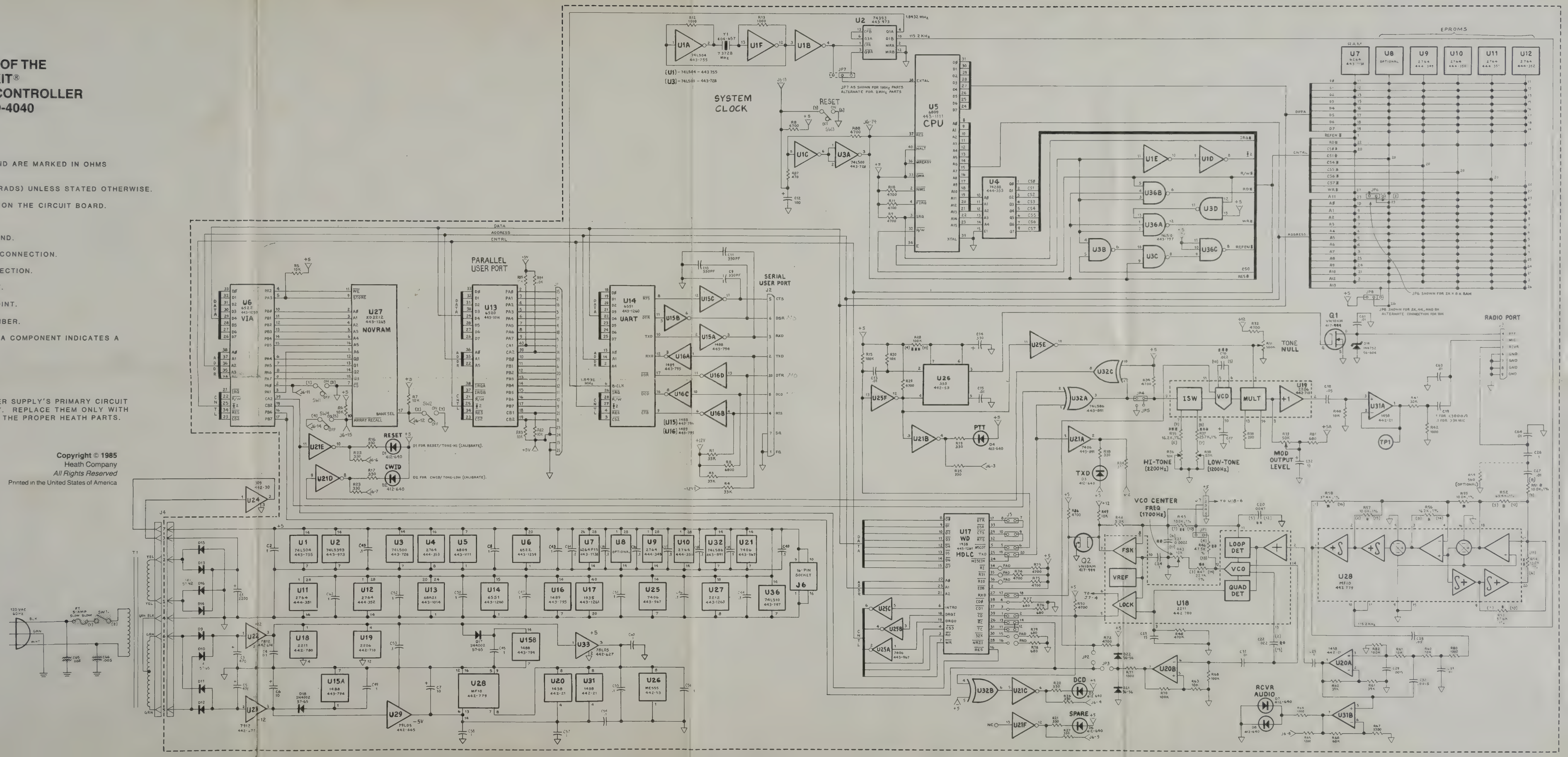
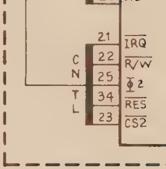


*** - U35 14 PIN PLUG.

13. PARTS IN SHADED AREAS IN THE POWER SUPPLY'S PRIMARY CIRCUIT ARE CRITICAL FOR CONTINUED SAFETY. REPLACE THEM ONLY WITH PARTS OF THE SAME RATING OR WITH THE PROPER HEATH PARTS.



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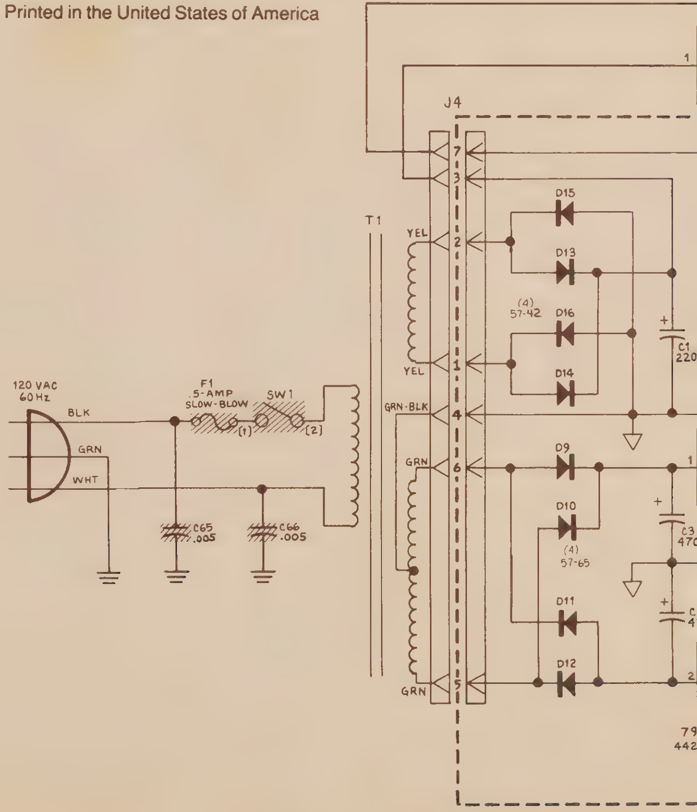

THEORY OF OPERATION

Refer to the Block Diagram while you read the following information.

CPU

The CPU (central processing unit) forms the heart of the TNC. It manages the operation of all the other system components. It does this by issuing commands on the control bus and addresses on the address bus; thus, it can send and receive data between itself and the various other system components via the data bus. In the same manner, it also retrieves its own instructions from ROM (Read Only Memory) in the memory area. These instructions, which are stored in ROM, form the program which enables the TNC to implement the communications protocol and to communicate with the user through an I/O (Input/Output) port.

The CPU consists of four main components. First, microprocessor U5 (6809) is the "brains" of the TNC. This is the device that executes the instructions of the program. Second, programmable ROM or PROM U4 (74S288) is the address decoder. It generates chip select signals to enable the proper device on the data bus at the proper time. Third, logic gates U3 (74LS00) and U36 (74LS10) generate the proper read, write, and memory refresh timing signals. Finally, sections D and E of inverter U1 (74LS04) buffer the system "E" clock for the other users of this clock signal in the system.

SYSTEM CLOCK

The system clock generates all the proper timing signals for the CPU and its peripheral devices (serial I/O, HDLC, and MODEM). The system clock consists of sections A, B, and F of U1, which make up the clock oscillator; and U2 (74LS393), which divides the clock oscillator frequency to generate the various different frequencies required by the clock users mentioned above.

SERIAL I/O

The serial I/O section consists of UART or Universal Asynchronous Receiver/Transmitter U14 (6551), along with U15 (75188) and U16 (75189), which are level translators. The UART receives data in parallel format from the CPU and sends it in serial format to the terminal for communication with the user of the TNC. The UART also receives serial data from the terminal and sends it in parallel format to the CPU on the system data bus. The level translators convert the signals from the TTL levels used by the TNC logic circuitry to the ± 12 volt levels compatible with the RS-232C interface standard.

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MEMORY

Memory is the system's component where instructions and data are stored. EPROM (Eraseable Programmable Read Only Memory) is used for program instructions and data which need not be changed during the operation of the system or lost when power is off.

RAM (Random Access Memory) is used for data, such as incoming and outgoing packets and system scratch variables, which will change. The TNC has a third type of memory, the NOVRAM (NOn- Volatile Random Access Memory). It is used for storage or infrequently changed parameters such as callsign, terminal baud rate, timing parameters, etc.

HDLC

HDLC (High-level Data Link Controller) U17 (1935) is a very important and complex device which performs several useful functions for the TNC. First, it helps to format data received from the CPU into packets for transmission over the air. Second, it generates and checks the FCS (Frame Check Sequence) which is used for error detection. Third, it processes formatted packets received off the air to check for errors and ship the required data to the CPU for further processing under the communications protocol. This device unloads a major portion of the work involved in implementing the lower layers of the protocol from the CPU. Thus, it allows the CPU to spend its time implementing the higher levels of the protocol.

MODEM

The **modem** consists of two main parts, the **mod**ulator and the **dem**odulator. The modulator converts the serial binary data from the HDLC controller to two tones (normally 1200 and 2200 Hz) which are used to modulate the radio carrier when the packet is actually sent out over the air. The demodulator converts the audio tones received off the air to serial binary data for the HDLC. The modulator consists of frequency-shift keyed signal-generator U19 (EXAR 2206), while U31A (1458) serves as an output buffer. The demodulator consists of U18 (2211), U20 (1458), U28 (MF10CN), and U31B. U18 (EXAR 2211) is a phase-locked loop FSK demodulator. U20A and U28 filter and frequency compensate the received audio signal for use by U18. U20B provides a clean signal to the HDLC controller for use during calibration of the modem. U31B is used to drive the LEDs that indicate proper audio signal level for the demodulator.

VIA

VIA (Versatile Interface Adapter) U6 (6522) performs several different functions. First, it is used to communicate with the NOVRAM. Second, the VIA provides a means by which the CPU can read the status of DIP switch SW-1. Third, it provides a programmable baud clock for the HDLC controller. Fourth, it is used to key the modem tones for the Morse code identification function. Finally, it is used to provide a system software real-time clock, which is used by the software in timing channel operations and other functions.

PARALLEL PORT

The parallel port passes parallel data between the CPU and external devices which require a parallel data format. The parallel port consists of PIA (Peripheral Interface Adapter) U13 (6520).

CIRCUIT DESCRIPTION

Refer to the Schematic (fold-in) and Block Diagram while you read the following information.

NOTES:

1. A negative-true logic level is denoted by a bar (that is, $\overline{IRQ}$ means IRQ is true at logic 0).

2. TTL logic levels are defined as greater than +2.4 volts but less than +5.25 volts for a "1", and less than +.8 volt but greater than −.4 volt for a "0".

CLOCK AND SYSTEM TIMING

The clock and system timing is concerned with the generation of signals needed for clocking the CPU (U5) and the baud rate of the serial user port, generating the power-on reset signal for on-board LSI (Large Scale Integrated) circuits, address decoding for chip selection by the CPU, and conversion of CPU control bus signals to the format required by the nonfamily peripheral devices (memory bank and HDLC controller). This circuit is Schottky-TTL based.

The frequency of the primary system clock is crystal-controlled at 7.3728 MHz by Y1 and sections A and F of U1 (74LS14). These sections are biased into linear operation by R12 and R13. The clock is buffered by U1B and passed to divider U2 (74LS393), a dual 4-stage binary counter. U2 provides a 1.8432 MHz clock for UART U14 (6551), and 115.2 kHz for U28 (MF-10), the modem input filter. Two taps are provided to U5 (6809) via jumper JP7 for quadrature clock generation at the bus frequency. The standard tap provides a clock of 3.6864 MHz, yielding a bus frequency of 921.6 kHz. The 7.3728 MHz tap provides a bus frequency of 1.8432 MHz when using high-speed components to support radio link data rates in excess of 4800 baud.

The power-on reset generator timing is controlled by RC network R8-C12. After power is applied, a delay of some 50- to 200 ms occurs before Schmitt trigger U1C fires. The negative-going output from U1-6 (pin 6) is inverted by U3A and applied to the CPU as well as being distributed by the system control bus as $\overline{RES}$(reset).

A system clock on the control bus is provided by buffering the E phase output from U5-34 through U1E and U1D.

The HDLC controller and system memory require a separate $\overline{RD}$ (read) and $\overline{WR}$ (write) control signal, which are not provided directly by U5. $\overline{RD}$ is generated by NAND'ing $R/\overline{W}$ and E from U5 through gate U36B (74LS10). Similarly, $\overline{WR}$ is generated by NAND'ing E with $\overline{R}/W$ (by inverting $R/\overline{W}$ with U3D) via U36A. The additional input to these $\overline{RD}$ and $\overline{WR}$ gates is tied to system $\overline{RES}$ to drive $\overline{RD}$ and $\overline{WR}$ high during reset, as may be required by certain RAMs used at U7 (6264) NOTE: See the memory bank on the next page.

Address decoding is provided by U4 (74S288), a high-speed Schottky bipolar PROM. The following table shows which particular address is selected.

ADDRESS	(HEX)	LINE	SIZE	FUNCTION	IC ENABLED
0000	1FFF	$\overline{\text{CS0}}$	8K	RAM	U7
2000	27FF	$\overline{\text{CS2}}$	2K	I/O	U6, U13, U14
2800	2FFF	$\overline{\text{CS3}}$	2K	HDLC	U17
4000	7FFF	$\overline{\text{CS1}}$	16K	RAM/ROM	U8
8000	9FFF	$\overline{\text{CS4}}$	8K	(EP)ROM	U9
A000	BFFF	$\overline{\text{CS5}}$	8K	(EP)ROM	U10
C000	DFFF	$\overline{\text{CS6}}$	8K	(EP)ROM	U11
E000	FFFF	CS7	8K	(EP)ROM	U12

The system used is called "incomplete address decoding," which means that an IC that requires only a few bytes of address space is allocated more than it needs; this, in turn, makes it accessible at multiple addresses. The primary addresses for the various I/O devices (which are the addresses actually used in the software routines) are:

IC	DESCRIPTION	ADDRESS RANGE (HEXADECIMAL)
U6	6522 VIA	2040 – 204F
U13	6520 PIA	2020 – 2023
U14	6551 UART	2010 – 2013
U17	1933 HDLC	2800 – 2807

In addition, certain logic has been provided for use with so-called "smart RAMs," which use dynamic RAM technology to achieve high density memory at lower cost than static RAM of comparable capacity. Specifically, many such memories require a pulse on pin 1 telling them when it is "safe" to perform an internal refresh operation without potential conflict with access requests by the CPU. This line is called refresh enable ($\overline{\text{REFEN}}$).

$\overline{\text{REFEN}}$ is asserted (made true — a logic "0" in this case) when $\overline{\text{RES}}$ is false, $\overline{\text{CS0}}$ is false, and the E clock is high. This only occurs when the PRNC is not in a hardware reset cycle, the chip (U7) is not selected, and the microprocessor is far enough into its current cycle to ensure that no glitches will occur on the $\overline{\text{CS0}}$ line.

The $\overline{\text{REFEN}}$ circuitry design was based on preliminary (limited) information and may not work with "smart RAMs" of any particular manufacturer.

CPU

A 6809 microprocessor acts as the system CPU. It executes the logical algorithms located in system EPROM.

The processor has an internal 2-phase clock generator and provides control, address, and data bus input/output for family peripheral devices. The control lines are modified for nonfamily devices as explained under "Clock and System Timing."

The 6809 has capabilities for position-independent code and is designed to support multiple stacks, making it very efficient for executing block-structured, high-level languages (such as Pascal, which is used to implement the VADCG and AX.25 protocols running on your TNC).

SERIAL USER PORT

The serial user port is designed to provide a full-duplex RS-232C interface for your terminal or personal computer. Full baud rate selection from 50 baud to 19.2 kilobaud is supported by the port. EIA RS-232C levels and transition rates are implemented as well. The on-board connector is a DB-25S type to conform with the RS-232C physical interface connector recommendation for modems (or Data Communications Equipment — DCE).

The serial I/O port is controlled by U14 (6551), a 6809 family part. The 6551 is a complete LSI UART (Universal Asynchronous Receiver/Transmitter) with an internal, software-controlled baud- rate generator. The transmitter and receiver are doubly-buffered and capable of interrupt-driven operation. The 6551 supports hardware flow control via its $\overline{\text{CTS}}$ (Clear To Send — for transmit) and $\overline{\text{RTS}}$ (Request To Send — for receive) pins.

The TTL I/O levels of U14 are translated to and from RS-232C levels and sensed by U15 (1488) and U16 (1489) buffers. U15's output transition rate of change is limited by capacitors C9 through C11 to ensure RS-232C compliance. D17 and D18 are incorporated to prevent power supply problems when abnormal conditions exist on the RS-232C lines.

All input lines to the TNC's RS-232C port are pulled up by resistors R1 through R4. This sets the correct defaults to allow the TNC to work with so-called "2-wire" serial data ports or other RS-232C subset implementations on the attached terminal. R1 asserts $\overline{\text{CTS}}$ so the TNC will send data to the terminal. R2, also an output, asserts $\overline{\text{DCD}}$ to allow the TNC to accept user data.

PARALLEL USER PORT

The parallel user port is designed as a general-purpose I/O port. It is currently used to output status information and debugging information. In addition, it is designed to support possible future accessories.

U13 (6520/6820/6821) is a 6809 family parallel interface chip that provides two TTL-level, 8-bit handshaking ports. It allows for easy interface to computers, ASCII keyboards, and other devices that may not support RS-232C serial I/O. Due to the lack of universal standards for such interfaces, the I/O levels are left as TTL; therefore, you are required to make such level changes as may be necessary for your equipment.

SYSTEM PORT, TIMERS, INDICATORS, AND NOVRAM

The system port consists of a dedicated-function parallel I/O device which communicates with the NOVRAM used for system configuration, the DIP switches, the HDLC controller RESET, and the indicator driver interface for various LED-monitored system functions. It also provides timers for HDLC baud rate generation, software timing functions, Morse code ID, and calibration of the modem frequencies. This section also includes the LED drivers.

The primary component in the system interface is U6 (6522), a very powerful 6809 family LSI part. The 6522 incorporates a pair of 8-bit programmable I/O ports, four control lines (for hand shaking or other use), two 16-bit programmable timer/counters, and an 8-bit shift register.

The A port of the 6522 is used to read DIP switch SW-1 at PA0 during initial system configuration. The remaining lines are used for 4-bit data bus I/O to and from NOVRAM U27 (XD2212), the high-order address line to U27 (A6 via PA1), and as the $\overline{\text{WE}}$ (write) and $\overline{\text{STORE}}$ (store) control lines to U27.

The 6522 B port is used to control the address bus (A0 through A5) of U27, and to provide output from Timer 1 (normally the HDLC baud rate controller) at PB6 and input to Timer 2 at PB7 during modem calibration.

The control lines are used as follows:

CA1 — Not used.

CA2 — HDLC reset and LED driver for modem calibration.

CB1 — Not used.

CB2 — Morse code ID output and LED driver for modem calibration.

U27 is a nonvolatile RAM. You may use this RAM to store system parameters that are normally not changed such as call sign, terminal attributes, and timing parameters. However, you may still alter these parameters whenever you wish.

The NOVRAM is a special type of integrated circuit (IC) memory that has two modes, volatile (temporary) and nonvolatile (permanent) storage.

In the volatile mode, NOVRAM still looks like ordinary RAM except that, when a power-off and then a power-on cycle occurs, the data in the NOVRAM is initialized from a form of permanent memory called EEPROM (Electrically Erasable Programmable Read Only Memory). This EEPROM, a sort of "shadow memory" for the RAM portion of the NOVRAM, is where you normally save your call sign and other parameters by setting the values, then performing a PERM command.

Note that, while the EEPROM portion of the NOVRAM chip is called "permanent," you can still change it as many times as you like (a minimum of 10,000 times) via the PERM command provided on the TNC.

The NOVRAM interface consists of the following:

$\overline{\text{WE}}$ (write-enable):	Stores data to RAM function (volatile).
$\overline{\text{STORE}}$ (store):	Saves data to ROM (non-volatile); 10,000 cycles minimum.
$\overline{\text{CS}}$ (chip enable):	Always true.
Q0-Q3 (data bus):	4-bit parallel interface.
A0-A6 (address bus):	128 4-bit locations (512 bits).
$\overline{\text{ARRAY RECALL}}$ (overrides $\overline{\text{STORE}}$ if Vcc drops below 3 volts) :	Transfers contents of ROM to RAM (no cycle limit).

U21 (7406) consists of six inverters with open-collector NPN transistors capable of sinking sufficient current to drive the LED indicators.

HDLC AND MODEM

The WD1935 controller is used to implement the HDLC standard bit-oriented protocol including CRC check sum and zero bit insertion. The modem consists of a phase-coherent AFSK modulator operating with 1200 and 2200 Hz tones (for Bell 202 compatibility), a PLL demodulator, and the necessary analog circuitry for interface with most common amateur communications equipment. A 60-second hardware "watchdog" timer is inserted in series with the transceiver activation line to prevent accidental RF channel lockout.

U17 (WD1935) is an LSI HDLC protocol controller with on-board PLL for clock recovery from NRZI-encoded data. This chip is interfaced to the system data and address busses directly, and to the control bus signals described above. Note that all data is inverted on transfer to or from the CPU, and the address assignments likewise reflect the inverted status of the address bus. The DRQO, DRQI and INTRQ interrupts are inverted via open-collector inverters U25A, B, and C (7406) for interface to the 6809 $\overline{\text{IRQ}}$ input. U17 is wired for selection of NRZI format and PLL clock recovery.

The transmit control signal from the HDLC chip $\overline{\text{MISCOT}}$ pin is fed through U25F and C13 to U26 (555), a monostable multivibrator with an approximate one-minute time period established by R28 (on 14-pin DIP header U35) and C14. The output from U26 drives Q1 (VN10KM), a power field-effect transistor (VFET) which, in turn, keys the transmitter via J3 pin 4.

The modem is based on the EXAR 2206/221 chip set for FSK operation. U19 (2206) provides a phase-coherent, low distortion, sine wave output at 1200 Hz and 2200 Hz for a 1200-baud Bell 202 compatible modulator. The output signal is buffered by U31A (1458) and sent to the transceiver interface connector. R33 is used to adjust the AC output level of the tone from a few millivolts to a few volts peak-to-peak. R36 sets the frequency of the 2200 Hz tone, while R38 sets the 1200 Hz tone. Input sources are selected by push-on/pull-off jumpers to allow HDLC data (JP4) or a fixed logic 1 or 0 (JP5). The fixed levels are for calibration of the modem tone frequencies.

Morse code is accomplished by using FSK tones. When not transmitting, the tone output is nulled. R31 is adjusted to provide a null in U19's output when U25-11 is in the low, or nontransmitting state. This allows voice override without disconnecting the TNC from the transmitter's input.

The demodulator is based on the EXAR 2211 PLL demodulator, which provides both data and a lock-detect output. R43 is used to set the unlocked frequency of the device for 1700 Hz for best demodulation of the input frequencies used. To satisfy the requirement for input tone balance to the 2211, a switched-capacitor filter based on the MF-10 (U28) is provided. The passband of the filter is tailored for typical 2-meter FM radios. The filter characteristics are determined by a resistor network plugged into a 16-pin header (U30) to allow other filter characteristics to be selected easily. The input level to the filter is monitored by LEDs D7 and D8 at the output of buffer U31B.

Jumpers are provided to allow for calibration of the modem (JP1 through JP5) and for disconnecting the modem from the HDLC chip (via J5). This flexibility allows the use of external modems for specialized and experimental applications, as well as using the on-board modem for other purposes.

MEMORY BANK

The memory bank consists of six JEDEC-standard 28-pin "byte-wide" sockets. One site (U7) is mapped for an 8K static RAM and four (U9-U12) are mapped as up to 16K EPROM or static RAM sites. The remaining site may be configured, via jumpers JP6 and JP8, to support a 2K through 16K EPROM, EEPROM, or RAM. The configuration supports 2716, 2732, 2764, and 27128-type EPROM devices, but not 2532 or 2564-type EPROM devices.

The JEDEC standard chosen (there are two) incorporates two-line control of the memory chip ($\overline{CE}$ and $\overline{OE}$). This simplifies the controller timing circuitry and allows multiple-sourced memory chips to be used. The PRNC is address-mapped for one 8K-by-8 static RAM chip, U7 (6264), to occupy low memory (0000 through 1FFF hexadecimal), and four 8K-by-8 chips (U9-U12) to occupy high memory (8000 through FFFF hexadecimal). U8 is mapped into the 16K space from 4000 through 7FFF hexadecimal. A replacement of the address decoder (U4) will allow other memory mappings to be used with no circuit board changes.

POWER SUPPLY

The power supply, which consists of two subsections, provides the needed voltages at the required current levels for proper TNC operation. Specifically, +12, −12, and −5 volts are supplied for the modem and RS-232C circuitry, and +5 volts is sent to all circuitry.

The primary +5 volt section utilizes a bridge rectifier (D13-D16) charging a large capacitor (C1). This raw DC is fed to regulator U24 (309). The output of U24 is decoupled by numerous .1 μF capacitors and distributed across the circuit board to the digital logic circuitry.

The ±12, −5 volt section incorporates a full-wave bridge rectifier (D9-D12) fed from a center-tapped winding. The split DC voltage obtained is filtered (C3 for +12 and C5 for −12 volts) and fed to regulators U22 (7812) for +12 and U23 (7912) for −12 volts. A portion of the −12 volts output is further regulated to −5 volts by U29 (79L05), while a portion of +12 volts is further regulated by U33 (78L05) to +5 volts for the modem section only. The resulting outputs are decoupled and distributed.

A wire-wrap area is provided, primarily for custom interfacing to your transceiver or, if required, for level shifting the parallel interface from TTL levels. For convenience, the wire- wrap area has power supply busses provided for +5, +12, −12 volts, and ground.

JUMPER PLACEMENT

Several jumper sockets are present on the circuit board. Some are used during the modem calibration procedure and others are provided for flexibility in satisfying individual configuration requirements. Jumpers are placed as follows for normal operation:

JP1 — (Normally on.) Removed to unlock the XR2211 VCO (U18) in order to allow measurement of its free-running center frequency during modem calibration.

JP2 — (Normally off.) Connected to allow the on-board counter to measure the tone frequencies generated by the XR2206 modulator (U19) during modem calibration.

JP3 — (Normally off.) Connected to allow the on-board counter to measure the voltage-controlled oscillator (VCO) frequency of the XR2211 phase-locked loop (PLL) tone decoder (U18) during modem calibration.

JP4 — (Normally on.) Connected to allow the on-board modem to accept data from the HDLC controller chip (U17). It is removed during modem calibration.

J5 — (Normally off.) Used during the modem calibration procedure to force a low (jumper on) or high (jumper off) control signal to the modulator during the modem calibration.

JP6 — Allows socket U8 (normally empty) to accept a 2K byte RAM chip (jumper to the left) or to accept an 8K byte RAM chip (jumper to the right).

JP7 — Selects the system clock speed. In the right position (normal), it selects a clock input to the microprocessor of 3.6864 MHz and a system clock speed of 921.6 kHz, which allows the TNC to operate with standard 1 MHz microprocessor and peripherals and slower access memories. In the left position, it selects a clock input to the processor of 7.3728 MHz and a system clock speed of 1.8432 MHz. In order to operate at this speed, the TNC requires high-speed parts and will support higher baud rates.

JP8 — Allows socket U8 (normally empty) to accept a 2K byte to an 8K byte memory IC (jumper to the left), or a 16K byte memory IC (jumper to the right).

In addition to the numbered jumpers listed above, there are eight jumpers normally installed in modem disconnect J5. (The second and eighth pin pairs, counting from the top of the connector, are unoccupied). These jumpers are necessary when you are using the on-board modem for packet communications, and are removed to connect an off-board modem. You may also remove these jumpers to experiment with the on-board modem for other uses. If you want to use an off-board modem, remove these jumpers and use J5 to connect a cable to your external modem. A detailed description of this connector is given in the "External Modem" section of the User's Manual.

DIP SWITCHES

The function of each of the DIP (Dual In-line Package) switches are detailed below.

NOTES:

1. The function of switch SW-1 is defined by software and may be changed in future software releases.
2. All commands referred to in this section are explained in detail in the "Commands and Messages" section of the User's Manual.

SW-1 [DEFAULT SELECT] (normally OFF)

This switch is read by the system software when you perform a reset.

ON — Instructs the software to initialize the operating parameters from the defaults stored in the system EPROM. **This switch must be in the ON position when you first turn on the TNC until you have stored your operating parameters in NOVRAM.** See the PERM command in the "Commands and Messages" section of the User's Manual. This switch also activates the autobaud routine.

OFF— Instructs the software to initialize the operating parameters from the values stored in NOVRAM. Following a "soft" reset (via the RESET command), the values may be the volatile, nonpermanent ones, or the nonvolatile values, depending on the setting of switch SW-4. The nonvolatile memory will be read following a power off/on cycle.

SW-2 [NOVRAM BANK] (normally ON)

Use this switch to choose one of two sets of NOVRAM-based parameters. This allows you to select from two different sets of operating parameters, allowing rapid reconfiguration for different applications such as ragchewing, mailbox systems, or two users. NOTE: Perform a "soft" reset immediately after you change the position of switch SW-1, or when you place power switch SW1 in the off position.

SW-3 [RESET] (normally OFF)

This is the system reset switch. To perform a "hard" reset, toggle this switch to ON, then OFF. It must be in the OFF position for the PRNC to operate.

SW-4 [NOVRAM DISCONNECT] (normally ON)

Use this switch to disconnect the NOVRAM from the system reset line when you use switch SW-3 to do a hardware reset. You may use this feature when you have a special set of parameters stored in NOVRAM that you wish to retain during a reset operation, but have not saved via the PERM command. This switch is normally left in the ON position, and the TNC probably will not power up if you leave it in the OFF position.

SEMICONDUCTOR IDENTIFICATION CHARTS

DIODES

COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	KEY NUMBER
D21, D22	56-56	1N4149	A1
D19	56-604	1N4752A	A1
D13, D14, D15, D16	57-42	3A1	A1
D9, D10, D11, D12, D17, D18	57-65	1N4002	A1

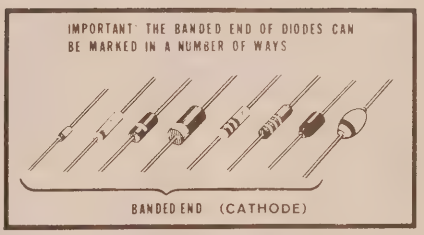
TRANSISTORS

Q1, Q2	417-999	VN10KM	B1

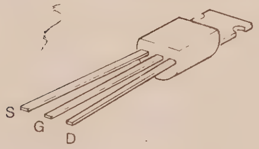
INTEGRATED CIRCUITS

U20, U31	442-21	1458	C1
U24	442-30	309	C2

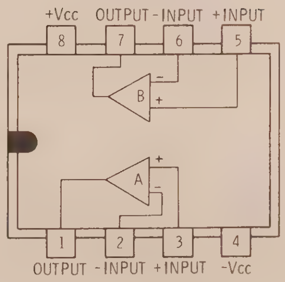
A1


IMPORTANT: THE BANDED END OF DIODES CAN BE MARKED IN A NUMBER OF WAYS
BANDED END (CATHODE)

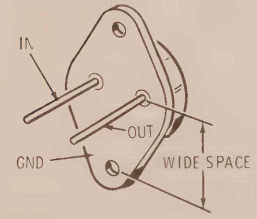
B1



C1

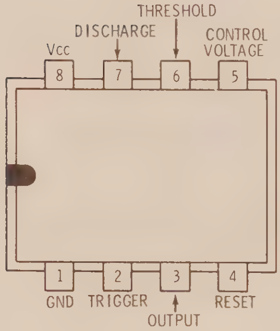


C2

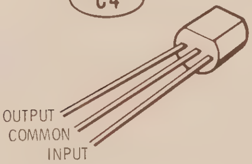


COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	KEY NUMBER
U26	442-53	555	C3
U33	442-627	78L05	C4
U29	442-665	79L05	C5
U22	442-674	7812	C6
U23	442-675	7912	C7
U19	442-710	2206	C8
U28	442-779	MF10	C9
U18	442-780	2211	C10
U3	443-728	74LS00	C11

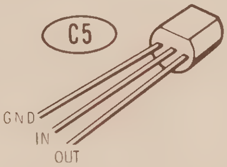
C3



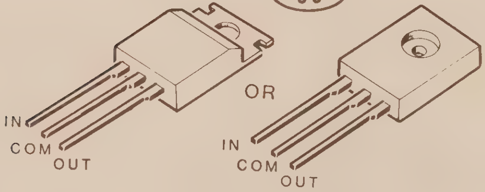
C4



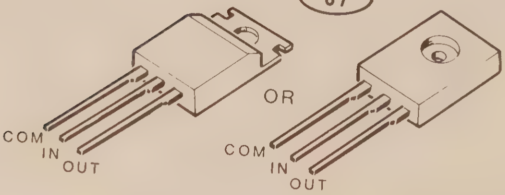
C5



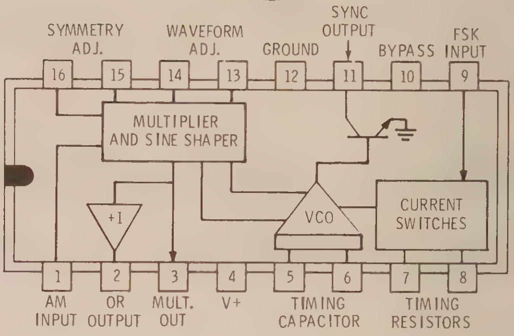
C6



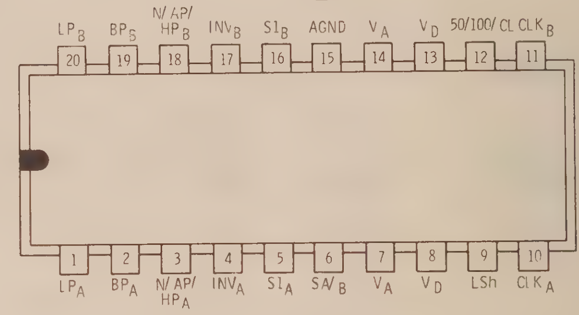
C7



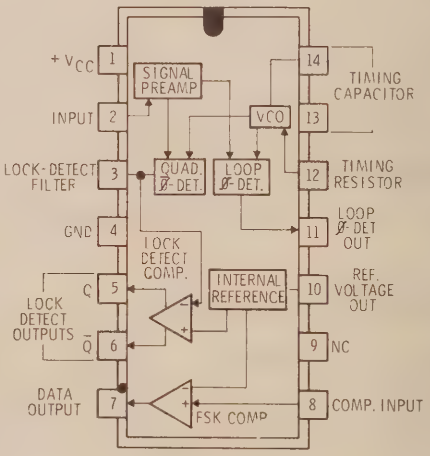
C8



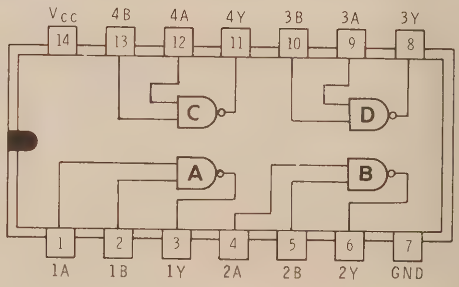
C9



C10

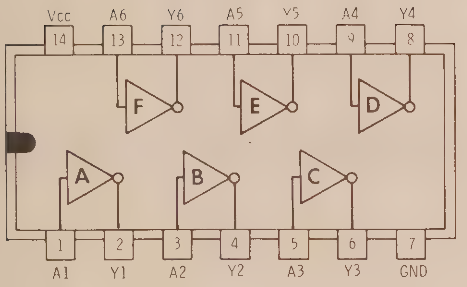


C11

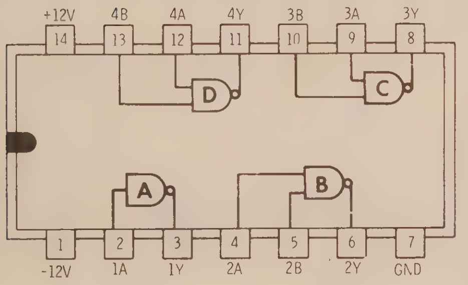


COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	KEY NUMBER
U1	443-755	74LS04	C12
U15	443-794	1488 or 75188	C13
U16	443-795	1489 or 75189	C14
U36	443-797	74LS10	C15
U32	443-891	74LS86	C16
U21, U25	443-967	7406	C17
U2	443-973	74LS393	C18

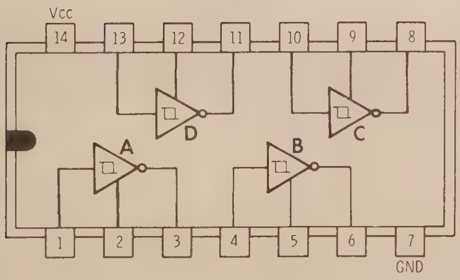
C12



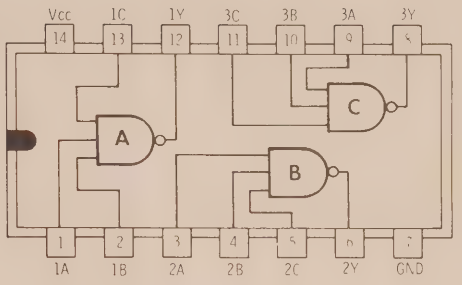
C13



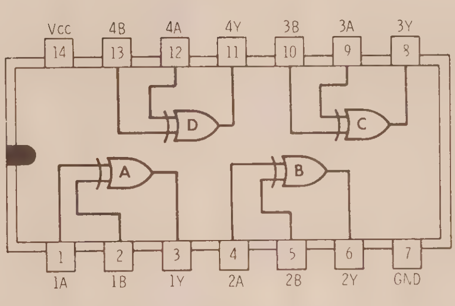
C14



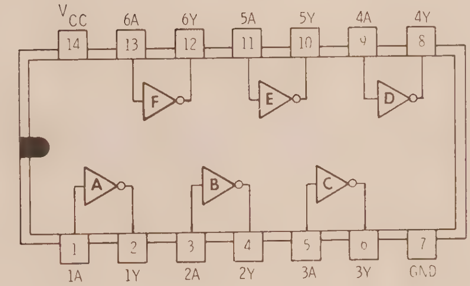
C15



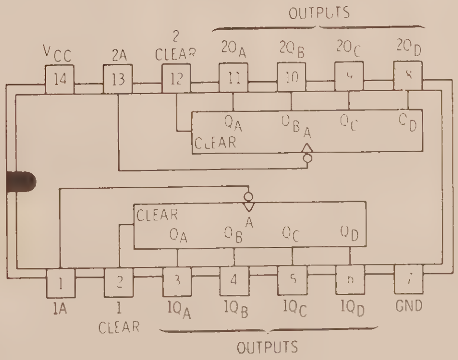
C16



C17

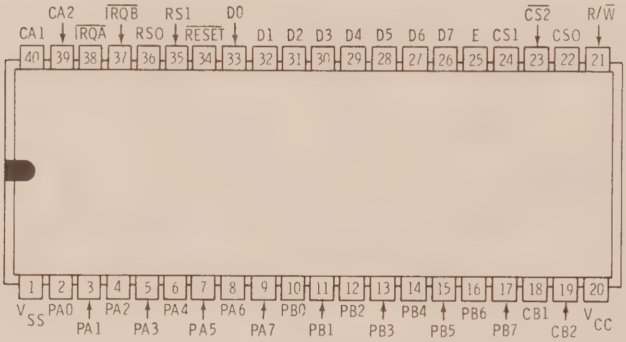


C18

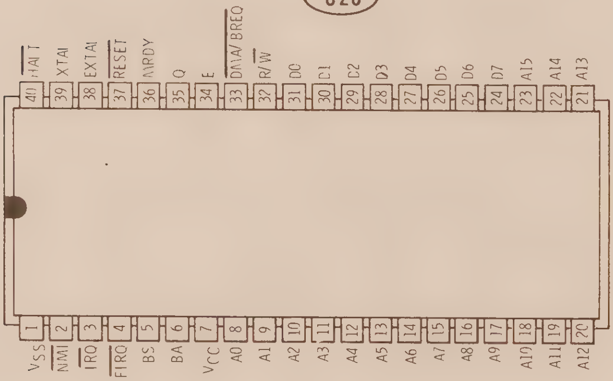


COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	KEY NUMBER
U13	443-1014	68A21	C19
U5	443-1111	6809	C20
U7	443-1138	6284	C21
U6	443-1259	6522	C22
U14	443-1260	6551	C23
U17	443-1261	1935	C24
U27	443-1263	2212	C25

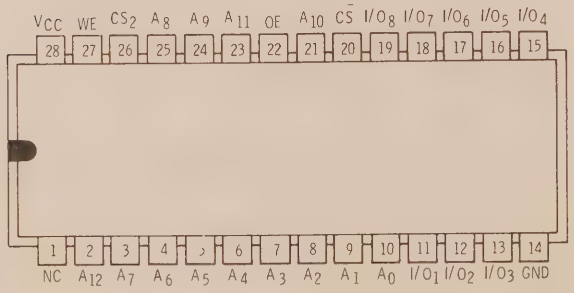
C19


CA1 CA2 IRQA IRQB RS0 RS1 RESET D0 D1 D2 D3 D4 D5 D6 D7 E CS1 CS2 CS0 R/W
40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
VSS PA0 PA1 PA2 PA3 PA4 PA5 PA6 PA7 PB0 PB1 PB2 PB3 PB4 PB5 PB6 PB7 CB1 CB2 VCC

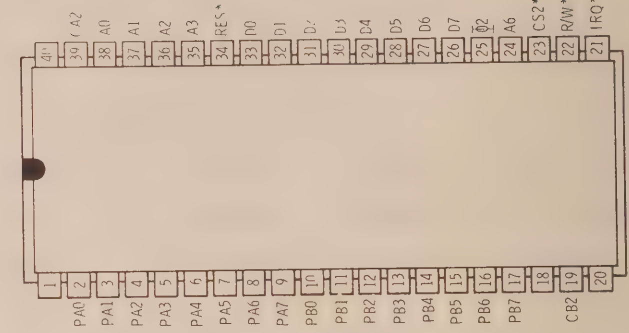
C20


HALT XTAL EXTAL RESET MRDY Q E DMA/BREQ R/W D0 D1 D2 D3 D4 D5 D6 D7 A15 A14 A13
40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
VSS NMI IRQ FIRQ BS BA VCC A0 A1 A2 A3 A4 A5 A6 A7 A8 A9 A10 A11 A12

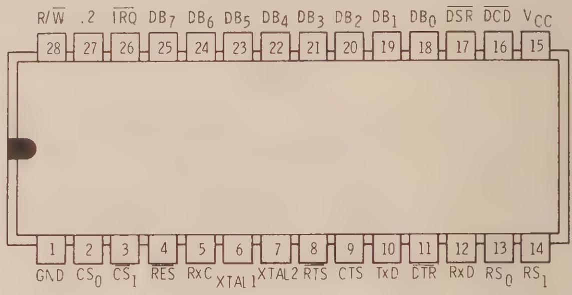
C21


VCC WE CS2 A8 A9 A11 OE A10 CS I/O8 I/O7 I/O6 I/O5 I/O4
28 27 26 25 24 23 22 21 20 19 18 17 16 15
1 2 3 4 5 6 7 8 9 10 11 12 13 14
NC A12 A7 A6 A5 A4 A3 A2 A1 A0 I/O1 I/O2 I/O3 GND

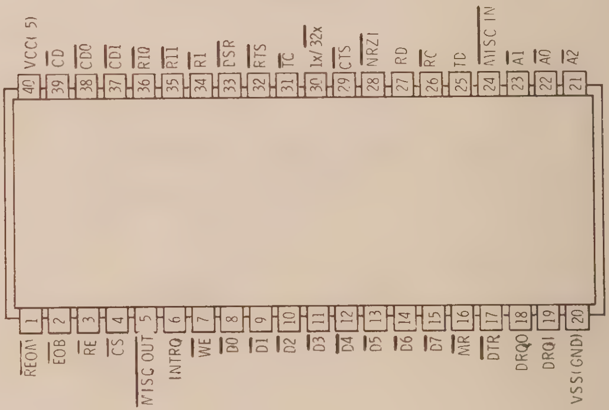
C22


CA2 A0 A1 A2 A3 RES* D0 D1 D2 D3 D4 D5 D6 D7 Φ2 A6 CS2* R/W* IRQ*
40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
PA0 PA1 PA2 PA3 PA4 PA5 PA6 PA7 PB0 PB1 PB2 PB3 PB4 PB5 PB6 PB7 CB2

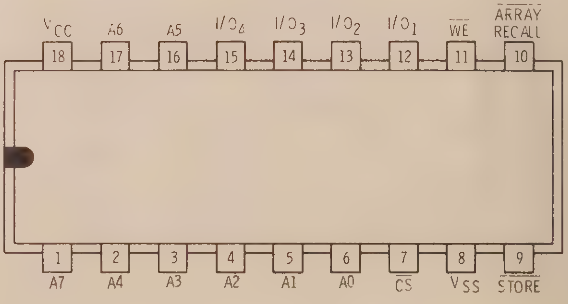
C23


R/W Φ2 IRQ DB7 DB6 DB5 DB4 DB3 DB2 DB1 DB0 DSR DCD VCC
28 27 26 25 24 23 22 21 20 19 18 17 16 15
1 2 3 4 5 6 7 8 9 10 11 12 13 14
GND CS0 CS1 RES RxC XTAL1 XTAL2 RTS CTS TxD DTR RxD RS0 RS1

C24

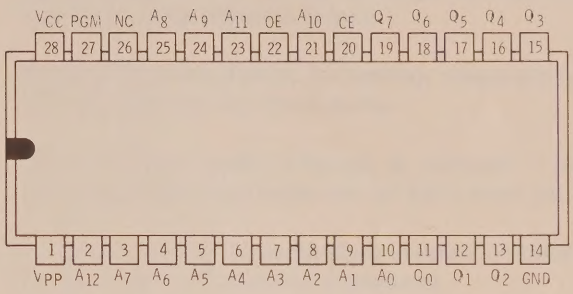

VCC(5) CD CD0 CD1 RI0 RI1 RI DSR RTS TC 1x/32x CTS NRZI RD RC TD NISC IN A1 A0 A2
40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
REOM EOB RE CS NISC OUT INTRQ WE D0 D1 D2 D3 D4 D5 D6 D7 MR DTR DRQO DRQI VSS(GND)

C25

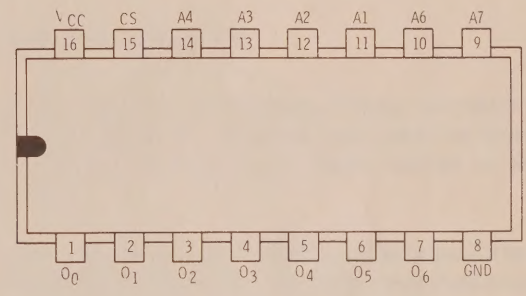

VCC A6 A5 I/O4 I/O3 I/O2 I/O1 WE ARRAY RECALL
18 17 16 15 14 13 12 11 10
1 2 3 4 5 6 7 8 9
A7 A4 A3 A2 A1 A0 CS VSS STORE

COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	KEY NUMBER
U9	444-349	Available only from Heath Co.	C26
U10	444-350	Available only from Heath Co.	C26
U11	444-351	Available only from Heath Co.	C26
U12	444-352	Available only from Heath Co.	C26
U4	444-353	Available only from Heath Co.	C27

C26



C27



CUSTOMER SERVICE

REPLACEMENT PARTS

Please provide complete information when you request replacements from either the factory or Heath Electronic Centers. Be certain to include the **HEATH** part number exactly as it appears in the parts list.

ORDERING FROM THE FACTORY

Print all of the information requested on the parts order form furnished with this product and mail it to Heath. For telephone orders (parts only) dial 616 982-3571. If you are unable to locate an order form, write us a letter or card including:

- Heath part number.
- Model number.
- Date of purchase.
- Location purchased or invoice number.
- Nature of the defect.
- Your payment or authorization for COD shipment of parts not covered by warranty.

Mail letters to:
Heath Company
Benton Harbor
MI 49022
Attn: Parts Replacement

Retain original parts until you receive replacements. Parts that should be returned to the factory will be listed on your packing slip.

OBTAINING REPLACEMENTS FROM HEATH ELECTRONIC CENTERS

For your convenience, "over the counter" replacement parts are available from the Heath Electronic Centers listed in your catalog. Be sure to bring in the original part and purchase invoice when you request a warranty replacement from a Heath Electronic Center.

TECHNICAL CONSULTATION

Need help with your kit? — Self-Service? — Construction? — Operation? — Call or write for assistance. you'll find our Technical Consultants eager to help with just about any technical problem except "customizing" for unique applications.

The effectiveness of our consultation service depends on the information you furnish. Be sure to tell us:

- The Model number and Series number from the blue and white label.
- The date of purchase.
- An exact description of the difficulty.
- Everything you have done in attempting to correct the problem.

Also include switch positions, connections to other units, operating procedures, voltage readings, and any other information you think might be helpful.

Please do not send parts for testing, unless this is specifically requested by our Consultants.

Hints: Telephone traffic is lightest at midweek — please be sure your Manual and notes are on hand when you call.

Heathkit Electronic Center facilities are also available for telephone or "walk-in" personal assistance.

REPAIR SERVICE

Service facilities are available, if they are needed, to repair your completed kit. (Kits that have been modified, soldered with paste flux or acid core solder, cannot be accepted for repair.)

If it is convenient, personally deliver your kit to a Heathkit Electronic Center. For warranty parts replacement, supply a copy of the invoice or sales slip.

If you prefer to ship your kit to the factory, attach a letter containing the following information directly to the unit:

- Your name and address.
- Date of purchase and invoice number.
- Copies of all correspondence relevant to the service of the kit.
- A brief description of the difficulty.
- Authorization to return your kit COD for the service and shipping charges. (This will reduce the possibility of delay.)

Check the equipment to see that all screws and parts are secured. (Do not include any wooden cabinets or color television picture tubes, as these are easily damaged in shipment. Do not include the kit Manual.) Place the equipment in a strong carton with at least THREE INCHES of *resilient* packing material (shredded paper, excelsior, etc.) on all sides. Use additional packing material where there are protrusions (control sticks, large knobs, etc.). If the unit weighs over 15 lbs., place this carton in another one with 3/4" of packing material between the two.

Seal the carton with reinforced gummed tape, tie it with a strong cord, and mark it "Fragile" on at least two sides. Remember, the carrier will not accept liability for shipping damage if the unit is insufficiently packed. Ship by prepaid express, United Parcel Service, or insured Parcel Post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

HEATH
ZENITH

HEATH COMPANY • BENTON HARBOR, MICHIGAN

THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM

LITHO IN U.S.A.